

RADIOLOGY

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INFECTIOUS GRANULOMAS OF BONES AND JOINTS, WITH SPECIAL REFERENCE TO COCCIDIOIDAL GRANULOMA¹

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 CCASIONAL infections of bone and joint, pathologically infectious granulomas, are caused by pathogenic fungi. They include blastomycosis, coccidial granuloma, actinomycosis, mycetoma, and torulosis. Because of their comparative rarity and resemblance, clinically and roentgenographically, to more common infections, they are readily overlooked. Diagnosis frequently comes as a surprise by recognition of the organism.

Presenting symptoms vary widely and cases will be seen by many kinds of medical workers. Positive diagnosis depends upon identification of the organism, therefore, upon general alertness, in order that this study be made. Proper cultures and animal inoculation are required, since the organisms are frequently not recovered by direct examination of discharges and tissues. Even on culture, the report is frequently "staphylococci" or "no growth." Repeated animal inoculation is sometimes required. Therefore, suspicion of mycosis should be readily roused and persistently followed. The roentgenologist will see cases properly studied and may aid diagnosis if there are criteria suggesting the diseases.

Our approach to mycosis of bone and

joint must be through coccidioid granuloma, 70 cases of which we have seen to date. Comparisons may be made with common infections, and attempted with other mycoses through the literature and our own few cases. The following description is made with reservation that the lesions observed are too few to include all types, and are particularly inadequate upon which to erect criteria for exclusion of the disease.

COCCIDIOIDAL GRANULOMA

By extension, lesions of bone may occur from adjacent primary infection of skin. A granulomatous node or intractable infection of skin develops to a slowly growing ulcer which may invade deeper structures. Lesions arising metastatically (the majority) may either arise in bone or invade it from adjacent soft tissue foci.

Origin in bone may be central or peripheral, epiphyseal or diaphyseal, in a region of cancellous bone. One lesion arising in tubular bone is not positively established. Peripheral lesions may rise subperiosteally or by extension from soft tissue. Except in the hand and foot, lesions by extension appear also to elect spongy bone. Spread to bone at ligamentous and tendinous attachments may partially explain a "bony prominence" predilection later to be mentioned. The

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typical in cases responding to treatment. The trabeculae may be thick and irregular, as described by Bromer (3) for osteomyelitis, or slender and well defined as in tuberculosis or osteitis fibrosa.

Lesions are usually multiple eventually, but a single lesion is often noted on first examination.

Epiphyseal cartilage and articular structures are an incomplete bar to extension.

Rapidity of advancement is very variable but slower than acute osteomyelitis, requiring several weeks or months for a display of progress on the film. Non-periosteal bone production is particularly slow.

Associated soft tissue swelling usually occurs with peripheral lesion, varying from slight to extreme.

Joints are usually involved from adjacent infection of bone or soft tissue. Infection may burrow extensively beneath the articular cartilage before it is destroyed and the joint visibly involved. Early articular involvements have occurred and a few which appeared primary, including two knees and a wrist. The only roentgen evidence of involvement may be excess articular fluid. Wandering joint pains are frequent in early general invasion before metastatic lesions are demonstrated, without evidence, then or later, of involvement of these joints. In such cases pulmonary involvement, presumably primary, is usually present.

A survey of 43 joints was made, giving attention to points used by Phemister (18, 19) in his comparison of tuberculous and infectious arthritis. Vertebral and sternoclavicular joints were excluded as not affording sufficient detail.

In 20, involvement appeared predominately osseous, in 10, general, in 13, predominately articular, and in 4, purely arthritic, without destruction of bone, except the articular cortex. Since the majority of all lesions are purely osseous and those which involve joints are not predominately articular this predilection appears contrary to that of tuberculosis.

Destruction of cartilage as determined

by a narrowed articular interval in 11 cases was general, in 11, opposite bone destruction, in 3, localization at a weight-bearing point might be inferred, in none was it evident at non-contacting regions of cartilage. In 18 there was no narrowing, due either to early involvement or to late lesions, with an increased articular interval.

Erosion of articular cortex in 15 cases was general, in 17, definitely adjacent to local bone destruction, in 2, a weight-bearing region appeared elected, and in 3 a non-contacting region of the joint. In 6, there was none.

The only clear predilection shown is to destruction of articular cortex and cartilage adjacent to bone destruction. No roentgen inference is seen of selective destruction of non-contacting cartilage, of selective preservation of weight-bearing cartilage, or of erosion of cortex beneath a dead but preserved cartilage, as demonstrated by Phemister in tuberculosis. He describes a secondary osseous extension from tuberculous arthritis, featured by invasion of both opposing bones. No tendency was seen to this symmetrical bilateral involvement in our cases. This appears to strengthen somewhat the conception that the lesions are primarily osseous.

No selective destruction of cartilage at weight-bearing points is seen in our cases, as described by Phemister in infectious arthritis.

Sequestra were seen at two joints, one probably in the suprapatellar sulcus of a knee, and two not certainly in a joint. These were separated from the bone, their origins not determinable. Opposed juxta-articular sequestra, described by Phemister in tuberculosis, appear not common.

Marginal grooving, described by Phemister in tuberculosis, was not seen. A slight marginal erosion of articular cortex in five cases may indicate a minor tendency to this manifestation of tuberculosis. Hypertrophic marginal lipping as found in hypertrophic arthritis deformans and late infectious arthritis was not seen.

origin of advanced lesions is often not determinable

Osseous involvement is predominately

ankle, giving a classical appearance of healed tuberculosis, complete bony ankylosis of an ankle (Fig 1-B)



Fig 1-A

Coccidioidal granuloma, chronic, responding to treatment. A Early lesion in the metaphysis of the tibia

Fig 1 B

B After extensive destruction there was repair and complete bony ankylosis. Advanced chronic atrophy

destructive, complete, or a partial 'permeation'. Margins of lesions may be "punched out" or diffuse.

Bone production is variable: many foci have none, some have it marginally, and a few have it within the focus of destruction. Rarely it predominates. The one sclerosis seen is so at variance with all the others that it cannot be accepted on the fact that it occurred in a proven case. Early or rapid lesions tend to partial destruction without production, chronic ones to complete central destruction, marginal osteogenesis, and circumscribed borders. The infections are intractable, may halt but seldom retrogress. Efficient healing is exceptional, but has been seen after intensive treatment by colloidal copper vaccine, and vigorous supportive measures, as, for example, a tarsal area completely excavated and bounded by smooth marginal cortex, regeneration of cervical spinous processes, osseous repair of the tubercle of a tibia, apparently complete arrest of an advanced involvement of an

Productive periostitis occurs frequently, but not necessarily with superficial involvement of bone. It is very variable in amount, usually scant, resembles that of similarly located tuberculosis, and occasionally profuse, particularly after operative intervention or with mixed infection. It is more marked in chronic cases and those with much soft part involvement. Periosteal bone is seldom smooth and well organized but remains irregular and incomplete. It is without parallel lamination, but frequently shows perpendicular striation. The lower extremity of a humerus, after curettage, developed profuse periostitis with perpendicular striation, extending far up the shaft (Fig 2). Periosteal production is slow and late as a rule compared with osteomyelitis.

Cystic appearances are seen: single or multilocular, circumscribed by more or less well organized bone, as described by Jungling (13) in tuberculosis, by Bromer (3) in osteomyelitis, and by Murdoch and Hutter (17) in leprosy. These are most

nences, as, the malleoli, tubercle of the tibia, the patella, extremities of the clavicle, angles, acromion and coracoid processes of the scapula, lesser trochanter of the femur, epicondyles of the humerus, olecranon and styloid processes of the ulna, styloid process of the radius. This appears to differ from non-mycotic infections.

All joints have been seen involved, except the shoulder joints proper, and the temporomandibular. Those most frequently involved are, in order, the ankle, knee, phalangeal, tarsal, carpal, and elbow. One of each, a hip, acromioclavicular, sternoclavicular, and sacro-iliac joints, were affected. The sparing of hip and shoulder is unlike tuberculosis and infectious arthritis.

Lesions at the Knee—Most frequent is a destruction starting at the tuberosity of the tibia (Fig 3), eroding directly through the bone, readily crossing the epiphyseal line of the tuberosity, fused or unfused, but not readily crossing the upper epiphyseal line, fused or unfused. The joint is usually involved late, if at all. Some apparent involvements appear due to swelling beneath the ligamentum patella without articular invasion.

Infections of the patella are next most frequent, starting at the upper or lower margins, anterior surface, or centrally. These invade the joint earlier than the tibial lesions but an osseous origin is usually clear. Periostitis occurs if the anterior surface of the patella is involved.

A few cases, either arising in the knee joint or invading it early, have been recognized since our former survey. These are particularly like tuberculosis, and are a small minority. One case showing articular swelling only had synovectomy under diagnosis of tuberculosis. Excised synovia revealed no tubercle bacilli, and *Coccidioides immitis* were found. Recovery followed operation and administration of colloidal copper and coccidioidin vaccine. No recurrence was evident at last report.

The ankle—Most lesions start in the malleoli, at their tips, superficial surfaces, or, less often, centrally (Fig 4). Adja-

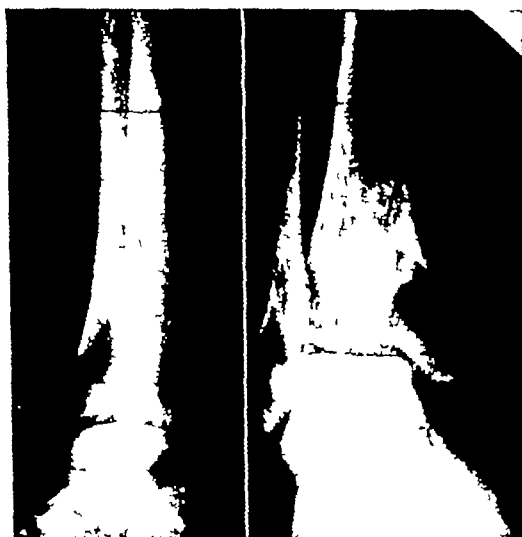


Fig 4 Coccidioidal granuloma. Extensive destruction at the base of a tibial malleolus, local erosion of articular cortex, no destruction of cartilage.

cent bone is invaded, the joint is usually involved after a considerable destruction of bone. There is usually scant irregular periosteal proliferation. One lesion rose in the anterior margin of the metaphysis of the tibia, invaded the joint, with eventual advanced general destruction, very tuberculosis-like, but ending in complete bony ankylosis (Fig 1). One infection extended to a malleolar tip from adjacent tarsal involvement.

Tarsal lesions appear almost exclusively osseous in origin, the infection frequently of the scattered destructive and productive type resembling osteomyelitis (Fig 5). With any degree of advancement adjacent joints are involved, soft part swelling is marked, regional atrophy marked and of acute type. The os calcis is most frequently involved.

Involvement in metacarpal, metatarsal, and phalangeal regions appears to arise in joints more frequently than elsewhere. Bone was always involved, usually with marked periostitis resembling the dactylitis of osteomyelitis, syphilis, and, to less extent, that of tuberculosis (Fig 6). Cystophorous involvement, with expansion of bone like that of tuberculosis, was not seen in these regions (12).



Fig 2 Coccidioidal granuloma. Extensive profuse periosteal production following curettage of a small focus in the lower extremity of the humerus. Extensive destruction of tubular bone which is unusual in this disease.

Fig 3 A

Coccidioidal granuloma. Typical lesion at the tubercle of a tibia. Complete healing of this osseous lesion. Advanced chronic atrophy.

Fig 3 B

Regional atrophy of spongiosa was present in all but one early case, varying greatly, averaging moderately advanced. Atrophy of nearby tubular cortex was present in 21 cases (about half), averaging slight. This appears to differ from tuberculosis and to be attributable to a more acute course, briefer, more complete disuse, causing acute decalcification of spongiosa with less of the slower atrophy of tubular bone. Two cases responding to treatment had well organized chronic atrophy of cancellous and tubular bone, squared epiphyses, and fusiform enlargement of joints, giving the classical appearance of tuberculosis (Fig 3-B).

A statement in our previous paper requires modification. 'Atrophy of disuse or of bone adjacent to involvement was not pronounced except in a few lesions of the wrist and ankle.' (5) There is mod-

erate atrophy, less pronounced, but similar to that of infectious arthritis.

Osseous lesions unassociated with joints caused no regional atrophy.

Soft tissue swelling about the joint was present in all but three cases. Swelling within the joint could be studied only where differentiating shadows are available, as at the knee and ankle. It was evident in 17 cases, in 6 not. It usually resembled that of infectious arthritis. In two cases it was fusiform, as in tuberculosis.

Articular swelling was a sole evidence of involvement in a few cases; other manifestations either never appearing or so long delayed that it may have been reactive only.

Peri articular periostitis was evident in 24 of 43 cases, averaging slight, its characteristics as previously described.

Regional Survey.—All bones except the facial bones have been involved. There is a predilection to so-called bony promi-



Fig 6 Coccidioidal granuloma metacarpo-phalangeal lesion. Marked periostitis



Fig 7 Coccidioidal granuloma at the elbow. Central lesion in the lateral epicondyle of the humerus, slight periostitis, no invasion of the joint

ficial destructions, obviously extended from soft part lesions

Vertebrae are attacked indiscriminately in bodies, neutral arches, transverse and spinous processes (Fig 9). Erosions of anterior margins of vertebral bodies occur, usually involving several. Some bodies may have wedge deformity as in tuberculosis. Some have central circumscribed destructions, solitary or multilocular without collapse. The intervertebral cartilage may or may not be affected.

The *pelvis* has central lesions of cancellous bone, like those seen elsewhere, usually multiple. A sacro-iliac joint in our file has localized involvement with a small destruction of adjoining bone, similar to tuberculous involvements of that region. I have been shown a film of a similar lesion by Dr Jacobson.

Altogether a bizarre group of lesions is presented. Surveyed as a group the multiplicity, peculiar locations and types of involvement are distinctly at variance with

commoner diseases affecting bone and joint. A single lesion without associated manifestations may have nothing to suggest mycosis. A solitary central osseous focus appears particularly obscure. However, this has seldom been a sole first manifestation. Lesions as described for the ankle, knee, skull, bony prominences, and spine, however, even singly appear legitimate grounds to suspect the disease.

Multiple lesions of bone and joint are apt to have an assortment at least highly suggestive of, if not incompatible with, non-mycotic disease.

Associated manifestations other than of bone and joint are usually present and of diagnostic aid.

Many cases have a pulmonary onset from which recovery, if it occurs, is slow and incomplete. With or without this history, the film usually shows enlargement of hilar and mediastinal glands and pulmonary lesions, tuberculosis-like, more resembling the juvenile type—vague, par-

Wrist—Involvement rose at the adjacent lower extremities of radius and ulna particularly at their styloid processes, at the base of a metacarpal bone, or within the carpus. The radiocarpal and the car-

at the inferior angle vertebral border, and at acromion and coracoid processes. The shoulder joint proper was not involved.

Elbow—are attached at the condyles of the humerus, olecranon process of the ulna



Fig. 5. Coccioidial granuloma tarsal lesion. Much bone production, early involvement of adjacent joints, marked acute regional atrophy.

pal joints were readily involved. Osseous involvement within the carpus was purely destructive. One infection appeared primarily articular, showing erosion of articular cortex but no visible bone destruction otherwise.

Hip—Only one lesion of the hip joint was seen, and that was peculiar. The first film to show pathology revealed complete dislocation without evidence of bone destruction or erosion of articular cortex. The condition of the cartilage was not revealed. Without history, traumatic dislocation would be diagnosed. The involvement appears purely articular. One destruction at a lesser trochanter was seen. Lesions about the hip are conspicuously rare in this series.

Shoulder—Clavicles are involved at their extremities, with or without evident invasion of joint. Scapulae are involved

and in juxta articular epiphysis. The elbow joint appears less readily involved than most (Fig. 7).

Skull—Circular or irregular purely destructive circumscribed lesions involve the outer table or both tables. Sometimes only the superficial part of the outer table is destroyed. The diameter of the destruction may be greater in the outer table, but the reverse is not seen. Subperiosteal abscess without bone destruction occurs. Superficial osteal origin is thus inferred (Fig. 8).

Ribs are involved by two main types of lesions, both purely destructive and without periostitis. The majority are "bitten out" marginal foci, the minority central foci. Occasional extension occurs to the rib from adjacent infections of the spine or from perivertebral abscess (Fig. 9).

Lesions of the *sternum* are usually super-



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Fig 7 Coccidioidal granuloma at the elbow. Central lesion in the lateral epicondyle of the humerus, slight periostitis, no invasion of the joint

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Figs. 8-A and 8-B

Coccidioidal granuloma of the skull. Note the greater diameter of the lesions in the outer table (A) and involvement of the outer table (B) not yet penetrating the inner table.

tial consolidations which may come and go, military infiltrations, less clearly defined than in tuberculosis, widespread patchy involvement is in a "bronchopneumonic" tuberculosis. Appearances like classical adult tuberculosis, with peripheral sub-apical accentuation, linear streaking of fibrosis, air-containing cavities, descending bronchogenic spread, clustered nodular involvements, have not come to autopsy proof. One such appearance supervening in known coccidioidal granuloma proved at necropsy to be due to coincident tuberculosis. One such pulmonary appearance remains as probable coccidioidal granuloma. The *Coccidioides immitis* were recovered by animal inoculation from the sputum, which was repeatedly negative for the tubercle bacillus. A film of the

chest is essential in any case of obscure lesion of bone or joint.

Cutaneous involvements are common, warty, granulomatous nodes, ulcers with granulomatous bases and undermined edges, persistent sinuses from deeper foci, or rarely a general pustular eruption. A node may be painless and inconspicuous, attracting attention only by ulceration while under observation.

Local lumpy, fluctuant subcutaneous abscesses, unassociated with bone, are frequent.

Glandular enlargements, widespread or local, may be seen. Cervical adenopathy is common. In the chest, hilar and mediastinal enlargements are especially frequent. Large abscesses of retroperitoneal glands may deform the psoas shadows on the film of the abdomen.

Symptoms of general infection and intoxication may be present, including loss of weight, strength and appetite, fever, night sweats, leukocytosis, wandering rheumatoid pains, and anemia.

Symptoms of meningitis may supervene, like those of tuberculosis. A meningeal termination is frequent in mycoses and is not a diagnostic point favoring tuberculosis. In the fulminating form it may occur early with only pulmonary involvement and inconspicuous lesions in skin, soft tissue, bone, or joint.

Almost any conceivable combination of manifestations may occur. Some are apt to be less consistent with the usual non-mycotic diseases. For instance, central lesions of spongiosa consistent with tuberculosis, Brodie's abscess, or neoplasm may combine with a malleolar involvement or cranial foci.

SYSTEMIC BLASTOMYCOSIS

Similar regions of the same bones have involvements strikingly alike. Similar lesions of long bone, ribs, spine, and cranium are seen. The classic description of Potter appears to apply almost equally well to both diseases (21).



Fig 9 Coccidioidal granuloma of the spine. All parts indiscriminately involved—extension to adjacent ribs



Fig 10 Actinomycosis. Superficial invasion of an iliac bone from a massive adjacent soft tissue lesion productive periostitis, calcareous bodies in the soft tissues

Both usually involve joints secondarily. Stober says of blastomycosis "In those necropsies in which opportunity was afforded to study changes in and about the joints communication with abscesses in the adjacent bone were always found," and, "extension by rupture of the epiphyseal abscesses was responsible for a majority of the joint lesions" (21).

The following descriptions of blastomycosis illustrate similarities

"An abscess two inches in diameter communicating with a region of softening in the parietal bone an inch in diameter, involving almost its entire thickness. An irregular perforation 8 mm in diameter existed in the inner table exposing the dura mater" (Churchill and Stober, 7).

The epiphyses of the lower end of the tibia and fibula also contained small yellowish softened areas communicating with abscesses

over both malleoli which had ruptured externally" (Lewison and Jackson, 14).

"Lesions developed in the following bones: Multiple lesions of the bones of the vault of the skull involving both tables, the right acromion process, medial ends of both clavicles and the manubrium, condyles of the right humerus, upper end and shaft of the right ulna, styloid process of the right radius, lower end and condyles of the left humerus, styloid process of the left radius, crests of the ilia, the right greater trochanter, middle third of the left femur, lower third of the right femur, upper poles of both patellae, right tibial tuberosity, right medial malleolus, distal ends of both first metatarsals, and a marginal lesion of the eighth rib" (Gaspar, Fenstermacher, and Lingeman, 11).

The last quotation is made at length because the numerous involvements cited and their accompanying illustrations ap-

pear classical for coccidioidal granuloma with one exception. Where we have only one debatable lesion arising in tubular bone, this case of blastomycosis has several

to consider the common characteristics of the two diseases as those of a "typical systemic mycosis" and to compare commoner infections and other mycoses with them.

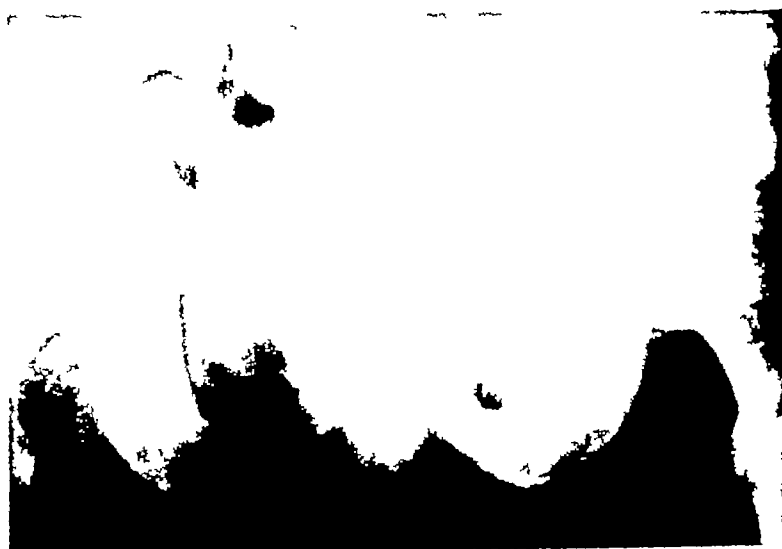


Fig. 11. Actinomycosis. Local destruction in the right pubic bone—marked spreading of the symphysis—apparently primary in bone or adjacent soft tissue.

Cystophorous lesions have been seen in our cases of coccidioidal granuloma and in blastomycosis appear to be shown in various illustrations of blastomycosis for example lesions described by Ruford (20) is multiple shotty dissolution of bone.

Both diseases have similar associated manifestations—frequent pulmonary onsets, constitutional symptoms, subcutaneous abscesses, cutaneous nodes, ulcers, sinuses, pustular eruptions, and meningeal terminations.

Systemic blastomycosis has more spontaneous remissions and is more amenable to treatment, particularly by iodides.

Coccidioidal granuloma, however, has responded to extra-intensive iodine treatment, Ball (1), Grey (5), Jacobson (personal communication).

Altogether, the two systemic diseases as described by various authors appear not to differ more than would the observations of men reporting on different cases of the same disease. It may be proper

ACTINOMYCOSIS

Actinomycosis is frequently primary about the mouth and in the gastro-intestinal tract particularly at the cecum, while coccidioidal granuloma has a few primary invasions of the oral region and none in the lower gastro-intestinal tract. Gastro-intestinal invasion is also significantly missing in autopsy reports of blastomycosis. Pulmonary actinomycosis is frequent, but with a greater tendency to pleural lesions with fibrosis, and to perforation through the chest wall. Miliary infiltrations appear less common.

Osseous involvement appears less common and more apt to extend from a single massive soft tissue lesion (Mattson, 16). One case showed extensive superficial involvement of an iliac bone adjacent to a massive actinomycotic lesion, presumably arising at the cecum (Fig. 10). There appears a greater tendency to profuse periosteal ossification in keeping with the more

chronic character of the disease. Local central lesions of cancellous bone appear less frequent, also invasion of the joints and evidence of widespread metastases. We have, however, one case of a lesion ap-

Actinomycotic lesions of the spine (Fig 13) are frequently reported resembling those of blastomycosis and coccidioidal granuloma (Tabb and Tucker, 22). All parts of the vertebrae are involved. The



Fig 12 Actinomycosis, by inoculation from a local cutaneous injury. Marked periostitis, diffuse productive and destructive lesion of the os calcis.

parently primary in a knee and one arising at the symphysis pubis (Fig 11). One lesion at an ankle resembles somewhat our coccidioidal cases, but with extreme periosteal proliferation (Fig 12). In two cases there were small oval calcareous shadows in involved soft tissues not seen in coccidioidal granuloma, tuberculosis, or in descriptions of blastomycosis. I have encountered one chest had numerous small calcareous nodules, a few millimeters in diameter, in the lung-fields similar to those in tuberculosis with fibrosis and calcification, but without the usual parenchymal manifestations seen in that disease.

lesions in the vertebral bodies are frequently sharply punched out, and without collapse, a type only unusually seen in tuberculosis (22). Actinomycosis appears to resemble blastomycosis and coccidioidal granuloma in absence of a predilection for articular structures, and in invasiveness.

TORULOSIS

Torulosis shows marked predilection for meningeal and cutaneous involvement, and skeletal infections are rare. We have been privileged to study one case, that of Dr John C. Wilson, which will be reported by him. A local lesion, apparently arising

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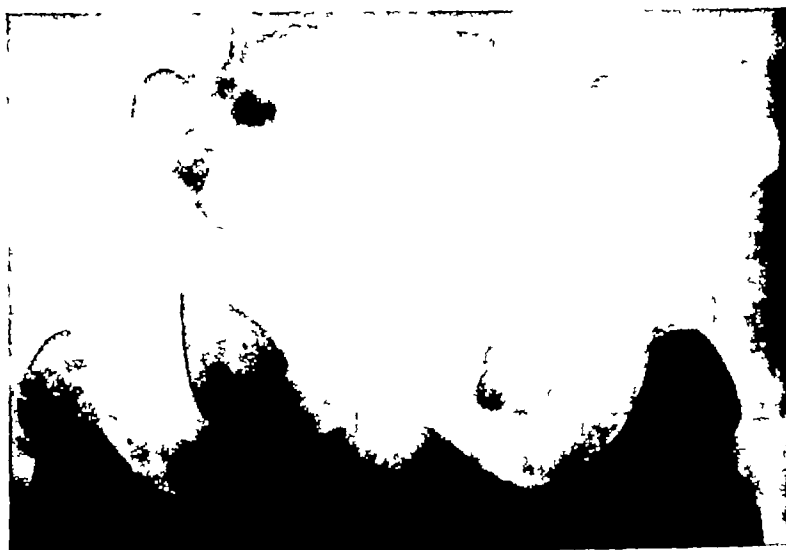


Fig 11 Actinomycosis. Local destruction in the right pubic bone marked spreading of the symphysis, apparently primary in bone or adjacent soft tissue

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losis usually is chronic, with complete rearrangement of cancellous structure and narrowing of tubular bone and wasted muscles so that these joints display the classical "fusiform swelling" Coccidio-

Tuberculosis of the tubular shaft, with its predominantly productive reactions and obvious periostitis, discussed by Bromer and Downs (4), has not been closely imitated in our cases of coccidioid granu-



Fig 14 Torulosis Destruction starts in bone near the joint, very invasive, producing a large granulomatous mass

des show, on the contrary, a more marked, more acute atrophy, with acute irregular decalcification of cancellous bone, acute soft tissue swelling, but less general wasting of muscles. Chronic coccidioides, partially arrested for years, has given the classical general appearance of tuberculosis (Figs 1-B and 3-B).

Tuberculosis has its more acute cases, with multiple lesions of skin, bone, and joint, in which no ready roentgen distinction is evident. Such appear to be Cases 11 and 15 of Lovett and Wolbrich (15), upon which they comment "curious punched out lesion of the skull was identified pathologically in two cases as being definitely tuberculosis." Case 15 particularly appeared mycosis-like.

loma. The possibility of such involvement cannot be excluded.

It is believed that the roentgen characteristics of coccidioid granuloma are present in only a minority of tuberculous lesions, and, when present, the chance of mycotic infection is so increased that the possibility is worthy of report. This is certainly true in a region where a mycotic infection is endemic. The possibility is definitely heightened in the adult when pulmonary lesions as above described are also present.

LEPROSY

Leprous osteomyelitis affects the bones of the hands and feet almost exclusively (Murdock and Hutter, 17). An indi-

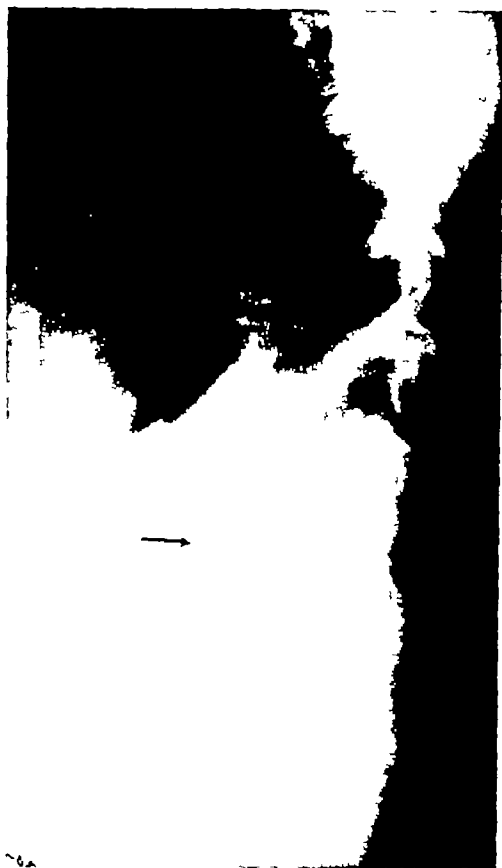


Fig 13 Actinomycosis Collapse of a vertebral body, anterior erosion of several vertebral bodies

in the condyle of a femur, produced a large granulomatous mass of neoplastic appearance, involving bone, articular structures, and overlying skin (Fig 14). This lesion showed a marked invasiveness, a feature frequently seen in mycoses. Comparisons cannot be made otherwise. A pulmonary lesion was present, somewhat resembling classical tuberculosis.

MYCETOMA

Mycetoma (Madurafoot)—A chronic diffuse infiltration of tissues, usually of a foot, by one of several varieties of ray fungi, but it is a disease distinct from actinomycosis. In characteristic advanced form the foot is tremendously swollen and has numerous sinuses. The universal permeation of tissues may leave bones diffusely

destroyed, and barely visible on the film (Fig 15). It is locally invasive, with no tendency to systemic spread.

TUBERCULOSIS

Both diseases have local destructions of spongiosa, independent of articular involvement. Both usually have some subperiosteal bone production if involvement reaches the periphery. Purely osseous involvement is a minor manifestation in tuberculosis, a major one in coccidioidal granuloma and blastomycosis. Bone production within the lesion is more scant in tuberculosis. Both may have bone production, particularly with the associated pyogenic infection, common in both diseases after sinuses are established. There appears little distinction in this type of osseous lesion in the two diseases. Coccidioidal granuloma has a bony prominence predilection, greater multiplicity, is more rapid, and has a much higher incidence of cutaneous nodes and ulcers.

Involvements of joints may in either case be purely or predominately articular. This is a minority manifestation in coccidioidal granuloma, a common or major one in tuberculosis. Destruction of juxta-articular bone is usually less pronounced and later in tuberculosis. Both spare articular cartilage more than infectious arthritis. In coccidioidal granuloma, one does not see destruction at non-opposed cartilage, juxta-articular sequestra, or marginal grooves. Lesions at tubercles of tibia, at the malleoli, or at other bony prominences are not common in tuberculosis. However, we have seen two tuberculous involvements arising at malleoli tips which resemble closely our coccidioidal ankles (Fig 16). The same joints are affected in both diseases, except that involvement of hip, elbow, and shoulder joints appears less common in the mycosis.

The evolution of tuberculous arthritis is usually slower, requiring years to reach the degree of advancement which coccidioides reaches in a few months. Correspondingly, regional atrophy of tubercu-

losis usually is chronic, with complete rearrangement of cancellous structure and narrowing of tubular bone and wasted muscles so that these joints display the classical "fusiform swelling" Coccidio-

Tuberculosis of the tubular shaft, with its predominantly productive reactions and obvious periostitis, discussed by Bromer and Downs (4), has not been closely imitated in our cases of coccidioid granu-



Fig 14 Torulosis Destruction starts in bone near the joint, very invasive, producing a large granulomatous mass

des show, on the contrary, a more marked, more acute atrophy, with acute irregular decalcification of cancellous bone, acute soft tissue swelling, but less general wasting of muscles Chronic coccidioides, partially arrested for years, has given the classical general appearance of tuberculosis (Figs 1-B and 3-B)

Tuberculosis has its more acute cases, with multiple lesions of skin, bone, and joint, in which no ready roentgen distinction is evident Such appear to be Cases 11 and 15 of Lovett and Wolbach (15), upon which they comment "curious punched-out lesion of the skull was identified pathologically in two cases as being definitely tuberculosis" Case 15 particularly appeared mycosis-like

loma The possibility of such involvement cannot be excluded

It is believed that the roentgen characteristics of coccidioid granuloma are present in only a minority of tuberculous lesions, and, when present, the chance of mycotic infection is so increased that the possibility is worthy of report This is certainly true in a region where a mycotic infection is endemic The possibility is definitely heightened in the adult when pulmonary lesions as above described are also present

LEPROSY

Leprous osteomyelitis affects the bones of the hands and feet almost exclusively (Murdock and Hutter, 17) An indi-



Fig 15 Mycetoma Diffuse invasive infiltration, bones grossly destroyed and decalcified throughout

vidual lesion might resemble coccidioidal granuloma closely. The very chronic course of leprosy, alternating improvement and advancement, and the associated trophic changes of "nicking," "slicing," "collar-buttoning," or gradual disappearance of terminal phalanges is unlike infections and the mycoses (Chamberlain, Wason, and Garland 6).

A cystophorous type of leprous osteitis is frequent (17) which appears to resemble most closely that of tuberculosis.

OSTEOMYELITIS

The usual osteomyelitis differs widely from coccidioidal granuloma. A comparable focal coccidioides occurs; it has less bone production, does not readily heal, does not extend readily to tubular bone, has not massive sequestra, involucra, or

widespread hyperemic decalcification, is less acute, and may have associated manifestations of mycosis.

The osteomyelitis of Garré differs radically, and is simulated by only one unproven sclerosing lesion.

Brodie's abscess in an epiphysis or cancellous diaphysis may be indistinguishable. It is less often multiple, is less invasive, is less prone to attack "bony prominences," has no mycosis-like associated symptoms, and less readily invades adjacent joints.

A cystophorous lesion may be seen in either disease.

We have no cystic coccidioidal lesion resembling closely the case of osteomyelitis illustrated by Bromer (3).

INFECTIOUS ARTHRITIS

In infectious arthritis, primary in the joint, the cartilage (Phemister, 18) is narrowed early by proteolytic digestion, accompanied only by erosion of articular cortex, and accentuated at weight-bearing points. If severe, the destruction of cartilage will be general and rapid. Clinical symptoms are more severe. Repair is earlier, associated with fibrous or bony ankylosis. Marginal exostosis, frequent in later stages of infectious arthritis, is not seen in coccidioidal granuloma.

Infectious arthritis by extension from an adjacent epiphyseal osteomyelitis resembles coccidioidal granuloma more closely. Here also the course is more rapid and cartilage is more quickly destroyed. Juxta-articular sequestra are more common, and repair occurs, with bone production. Ankylosis or marginal exostosis may be present.

SYPHILIS

Congenital syphilis whose principal effects are at epiphyseal cartilage and adjacent diaphysis should only occasionally be simulated. Acquired proliferative syphilis of bone with irregular sclerosis, marked periostitis, and ready involvement of tubular bone appears fundamentally unlike coccidioidal granuloma. Local

gummata may resemble coccidioidal granuloma on the film. More bone production and periostitis would be expected, but would not be conclusive. Syphilis of the clavicle readily involves its tubular region and is not limited to its extremities.

In all cases, the more indolent course, more bone production, periostitis, frequent regressions, serologic reaction, clinical symptoms, and response to treatment should indicate syphilis.

COMMENT

Skeletal mycotic infections appear by group survey to resemble each other more than the common infections, tuberculosis, pyogenic infection, and syphilis. They resemble tuberculosis more closely than the other two. Coccidioidal granuloma and blastomycosis are very similar.

What may be termed "mycotic predilections" include lesions solitary rather than scattering, selective involvement of spongy bone, articular lesions obviously extended from bone, local infections intractable to conventional treatment, multiple foci, including non-skeletal ones, cutaneous, subcutaneous, glandular and pulmonary, from which ready blood vascular dissemination is inferred, invasiveness greater than in most infections but, in spite of this, less tendency to involve tubular bone. The more acute widely disseminated tuberculous involvements are particularly mycosis-like. Punched-out lesions of the skull, involvements of spine not limited to vertebral bodies or intervertebral discs, and intrathoracic infections which penetrate the chest wall are particularly suggestive.

These so-called mycotic characteristics have little or nothing pathognomonic. Group differences are readily erected but it is difficult to present positive points of distinction. Where single lesions are presented there may be little or nothing to suggest mycosis. Where foci are multiple and varied a tentative diagnosis may be justifiable. Positive diagnosis does not appear available on the film. It appears

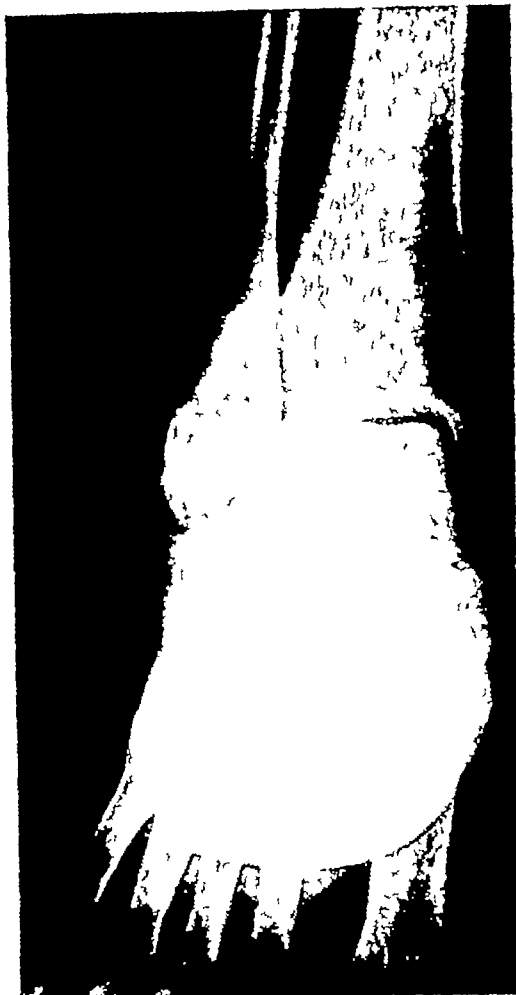


Fig 16 Tuberculous osteomyelitis arising at a malleolus closely resembling that of coccidioidal granuloma. No articular invasion.

pertinent to cite the warning of Lovett and Wolbach (15) "The diagnosis of infectious lesions of bone would be simple if each infectious agent always produced the same reaction."

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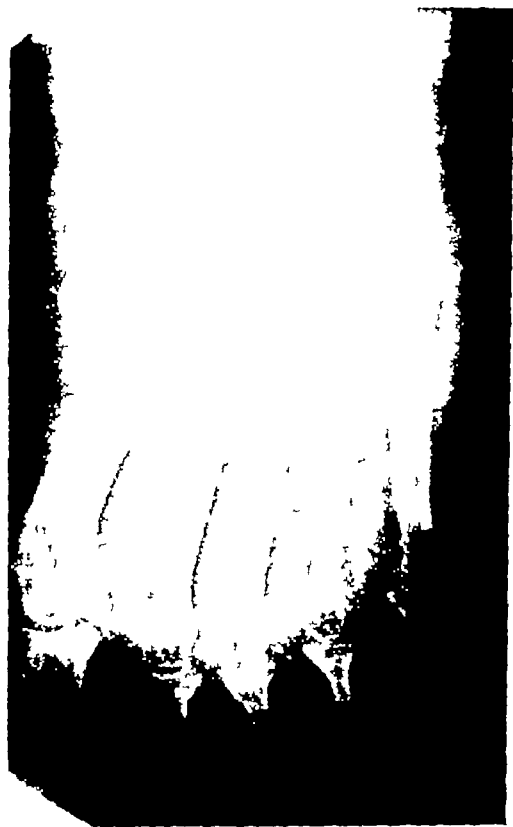


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LYMPHOBLASTOMA A GENERALIZED DISEASE¹

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A COMPLETE discussion of the various manifestations of lymphoblastoma is, of course, impossible in a presentation of this kind. I shall, therefore, only attempt an outline of the general course of the disease, with a more detailed discussion of the roentgen findings in some of the organs where it is frequently overlooked.

The term "lymphoblastoma," as suggested by Mallory, has recently been defined and elaborated by Viets and Hunter. The classification which they suggest seems to me to be the best yet published, and is a definite advance in clearing up the confusion of terminology found in the literature. In their classification, such terms as lymphosarcoma, Hodgkin's disease, lymphogranulomas, pseudoleukemia, lymphatic leukemia in its aleukemia form, and the skin manifestations of lymphoblastoma, mycosis fungoides, are grouped under the general term "lymphoblastoma."

A qualifying clinical term is added to distinguish the various forms, thus lymphatic leukemia, becomes lymphoblastoma leukemicum, aleukemic lymphatic leukemia, lymphoblastoma aleukemicum, mucosis fungoides, lymphoblastoma cutis, Hodgkin's disease, lymphoblastoma (Hodgkin's type), and lymphosarcoma, lymphoblastoma (infiltrating type). There are many cases on record of leukemia becoming aleukemia or even pseudoleukemic, and of Hodgkin's disease showing sarcomatoid infiltration of the skin, like those of mycosis fungoides. This broad method of classification should lead to a better understanding of this group of diseases.

Lymphoblastoma may then be described as a progressive generalized disease, almost invariably fatal, occurring at any age, in

either sex, and involving any tissue of the body, although it is primarily in the glands of the neck and mediastinum. It may, or may not, be accompanied by changes in the blood cells. Occasionally, it is rapidly fatal, more often it runs a chronic course. The response to irradiation is usually prompt and striking, the masses disappear rapidly under adequate treatment and often do not recur in the same location. In the early stages of the disease, the patient recovers his strength and ability to work after each treatment. As the disease progresses, recovery is less definite and eventually fails completely, at this time there is usually involvement of the liver, and the patient may develop a temperature, ascites, edema, and amenia. The progress of the disease from this time on is rapid and fatal.

In making the diagnosis perhaps the most important single factor is that the examiner keep this disease in mind when studying an obscure case. Where the typical picture of large cervical glands is present, the diagnosis is easy in most cases. When the presenting symptoms are abdominal or thoracic, the diagnosis may be most difficult. The roentgen findings in these cases, although not characteristic, are of the greatest importance in establishing a correct diagnosis. The final diagnosis is usually made by biopsy, and this procedure should never be neglected, whenever possible. The roentgen findings of diagnostic importance, in the various manifestations of this disease, follow.

CHEST

In the chest, when lymphoblastoma involves the mediastinum or lung field, a variation from the normal can usually be demonstrated. The difficulty is in differentiating the findings from other causes

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moved elsewhere, or upon the reaction of the tumor mass to irradiation. It is very unusual for a true lymphoblastoma, uncomplicated, to fail to respond favorably to irradiation. In those cases complicated by tuberculosis, the biopsy may be misleading, and the x-ray findings extremely difficult to interpret. The diagnosis usually rests upon the finding of tubercle bacilli in the sputum, the failure of the lesion to disappear under proper irradiation, and the persistence of temperature. Involvement of the pleura or extensive miliary-like lesions in the lung are usually seen in the advanced stages of the disease, and the diagnosis can be made on evidence found elsewhere. It is only essential that the roentgenologist know that these findings may be of lymphomatous origin, and that it is not necessary to explain the picture in some other way.

LYMPHOMA OF THE GASTRO-INTESTINAL TRACT

Abdominal symptoms have been the presenting complaint in about 25 per cent of the cases with lymphoblastoma appearing in our Clinic. The lesion may occur anywhere in the gastro-intestinal tract, but is most frequently seen in the stomach and small bowel. It is more often a multiple rather than a single lesion, and, since other malignant tumors in the gastro-intestinal tract are rarely multiple, this, in itself, is of some diagnostic value. The disease frequently involves the abdominal glands, but it is when some part of the gastro-intestinal mucosa is involved that the characteristic picture is seen.

A study of the literature and the material in our Clinic has recently been made by Martin in an attempt to establish criteria which would make possible a roentgen diagnosis in this disease. The involvement of the gastro-intestinal tract does not appear to depend at all upon the type of lymphoma present. In the early literature, most of the cases reported were of the infiltrating type, and it was not until 1913,



Fig 2 A case of lymphoblastoma of the Hodgkin's type showing gastrointestinal lesions. The film was taken with only a small amount of barium in the stomach—the characteristic gyroscopy rugae are well shown. The findings were confirmed at autopsy. The enlarged rugae are general throughout the stomach. At the point indicated by the arrow A definite tumor mass is visible.

that the first cases of gastro-intestinal involvement of the Hodgkin's type were reported. This probably accounts for the general feeling among clinicians that Hodgkin's disease rarely, if ever, involves the gastro-intestinal tract. As a matter of fact, there are more reported cases of this type than any other. The gross pathologic appearance of the lesion varies widely, but they are usually multiple. A fact of considerable importance is the differentiation from other gastro-intestinal tumors. The location of the lesions within the gastro-intestine is also variable, but a common site is in the region of the pylorus or ileocecal valve. When the stomach is involved, there is often an accompanying lesion in the duodenum or upper portion of the small bowel. With involvement of the cecum, there is frequently an involvement of the terminal ileum. Occasionally, the



Fig 1 Pulmonary manifestation in a case of lymphoblastoma of the Hodgkins type. The right lung field is distinctly smaller and less radiant than the left. The hilus glands are moderately enlarged, and on the right side there is a band of mottled dullness extending across the chest from the hilus to the axillary border. In the lateral view the process could be seen extending outward along the interlobar septum but there was actual infiltration of the lung tissue. The patient was a young man of 23 years. The presenting findings were glands in the neck. The diagnosis was confirmed by biopsy. The pulmonary symptoms did not develop until the patient had been under observation and treatment for about three years.

Usually, the disease first involves the peritracheal glands, as pointed out by Wessler and Greene many years ago. As the disease progresses, the hilus and peribronchial glands become enlarged, and in the later stages there may be actual infiltration of lung tissue. In rare atypical cases a miliary-like process may be seen throughout the lung due to general involvement of the lymphoid tissues. Frequently, there is extension to the pleura with accumulations of fluid within the pleural spaces. In those cases which have received irradiation over the chest, the picture becomes even more complicated. With the destruction of lymphoid tissue fibrosis may appear and narrow bands of dense tissue are seen radiating outward from the hilus. If the lung itself was involved before irradiation was given actual areas of fibrosis

within the lung substance may be seen so that the picture very closely resembles that of tuberculosis. When it is remembered that these cases are not infrequently complicated by tuberculosis, the diagnosis becomes increasingly difficult.

The roentgen findings in typical cases should consist, in the early stages of the disease, of a widening of the supracardiac shadow, the borders of which are lobulated. This increase in the mid-shadow may occur on one side only, but it is usually present on both sides. The shadow is quite dense, with sharply defined margins. There is no limitation of respiratory motion or infiltration of the lung itself. Occasionally, a single large rounded mass may appear to one or the other side of the mid-shadow just above the hilus, somewhat resembling an aneurysm. The trachea may, or may not, be displaced or narrowed. Usually, there is no displacement of the heart or great vessels. In the later stages of the disease, there may be an enormous increase in the mid-shadow extending well down into the hilus region. However, the borders retain their lobulated appearance and there is usually an absence of displacement of the mediastinal contents, and of interference with the passage of air into the lungs, the position and respiratory movements of the diaphragm are normal.

The lesions are differentiated from glandular tuberculosis by their size and extent, and by the absence of calcification within the masses. From carcinoma, the differentiation is based largely on the lobulated appearance of the shadows, their size, and the absence of interference with the flow of air to and from the bronchi. Since most carcinomas are bronchial in origin obstruction occurs early—this is not true in lymphoma. From aneurysm, the differentiation can usually be made by rotating the patient under fluoroscopic observation or by taking films in the first and second oblique positions. It can usually be shown that the mass is not connected with the aortic shadow.

The final diagnosis is usually made from the histologic appearance of a gland re-

the kidney, but up to the present time have not been able to do so, and it is doubtful if it has any characteristic appearance. The same is probably true with involvement of the spinal cord.

CONCLUSIONS

In conclusion, I would again call attention to the importance of keeping the possibility of lymphoblastoma in mind in obscure cases, and the value to the roentgenologist of considering it as a generalized disease which may involve almost any organ of the body. It is particularly impor-

tant that the roentgenologist be familiar with the appearance of this lesion in the gastro-intestinal tract, since a lack of this knowledge may result in serious mistakes. If a diagnosis of carcinoma is made, and the lesion is considered too far advanced for surgical treatment, either the benefit derived from irradiation may be neglected or an overdose of irradiation given, resulting in serious injury to the patient.

The knowledge that this process may attack almost any organ enables the roentgentherapist to correctly interpret unusual symptoms arising in the course of the disease and to apply adequate treatment.

disease may appear as a single lesion in the stomach, cecum, or ileum, and permanent cures have been obtained by the surgical removal of such lesions. The gross appearance is that of an infiltrating tumor rarely accompanied by ulcerations, they may project into the lumen of the involved viscus, or they may produce a generalized contraction of the organ. Frequently, there is marked change in the mucosa of the organ involved. This change is more marked than in other tumors, and is particularly well shown in the stomach where the typical gyrosopic rugæ are seen. In these cases, the folds of gastric mucosa resemble somewhat the convolutions of the brain.

The roentgen findings in lymphoblastoma of the gastro-intestinal tract are not characteristic, and the lesion is frequently mistaken for carcinoma which it closely resembles. The finding of greatest importance, which should lead the examiner to suspect lymphoblastoma is a multiple lesion, particularly one involving both the stomach and duodenum. The lesion in the stomach resembles carcinoma, that in the duodenum ulcer with changes in the gastric or intestinal mucosa.

In our experience, the typical gyrosopic rugæ have been present in a high percentage of cases and have been found only once where lymphoblastoma was not present. Lymphoblastoma is usually accompanied by an enlargement of the spleen which can often be demonstrated during the examination of the gastro-intestinal tract by the roentgen ray, the fundus of the stomach may be displaced downward and to the right, and the space between it and the diaphragm increased. Lymphomatous infiltration of the stomach is less likely to interfere with the passage of the peristaltic wave or with the emptying time of the stomach than other similar lesions. In the typical cases with multiple lesions, gyrosopic rugæ, and enlargement of the spleen the diagnosis can be made with considerable certainty from the roentgen examination alone. In less typical cases, a search elsewhere in the body with the removal of

a specimen for microscopic section, is usually necessary to establish the diagnosis. In the treatment of these cases, it is our belief that irradiation, when possible, should be preceded by surgical removal of the tumor mass. The rapid breaking down of such a tumor under irradiation may result in perforation and peritonitis. This is less likely to occur if the mass of the tumor has been removed. In all cases, the treatment should be given with the greatest care. If radiation treatment is planned in a given case, one can readily see that it is of the greatest importance to establish the diagnosis between carcinoma and lymphoblastoma, the carcinoma dose would be highly dangerous in these cases.

LYMPHOBLASTOMA OF THE BONE

Lymphoblastoma of the bone is an uncommon finding and probably always secondary to involvement elsewhere, although the lesion in the bone may be the presenting symptoms. The bone most frequently involved is the sternum. Dresser, in 1926, reported three cases from our Clinic, and up to that time we had not observed this lesion in any other bone. Since then, we have observed an occasional case, and have found lesions not only in the sternum but in the spine and long bones. In all cases, however, the disease has been confined to the cancellous portions of the bone, and is a purely destructive process without evidence of new bone formation or of periosteal proliferation. They closely resemble metastatic carcinoma in bone but are usually a single lesion, whereas carcinomatous metastases are usually multiple. Their response to small doses of irradiation is a sign of some diagnostic value.

Lymphoblastoma frequently involves the brain, cord, urinary tract and may involve any organ of the body. We have not been able to demonstrate its presence in any system other than the three just described. It should be possible to demonstrate the lesion when it occurs in the pelvis.

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Lymphoblastoma frequently involves the brain, cord, urinary tract, and may involve any organ of the body. We have not been able to demonstrate its presence in any system other than the three just described. It should be possible to demonstrate the lesion when it occurs in the pelvis

charged guard wires stretched across the open faces of chamber, the potentials of the wires being divided in equal successive

scale S , which also serves as a "handle" with which to move the system from the outside

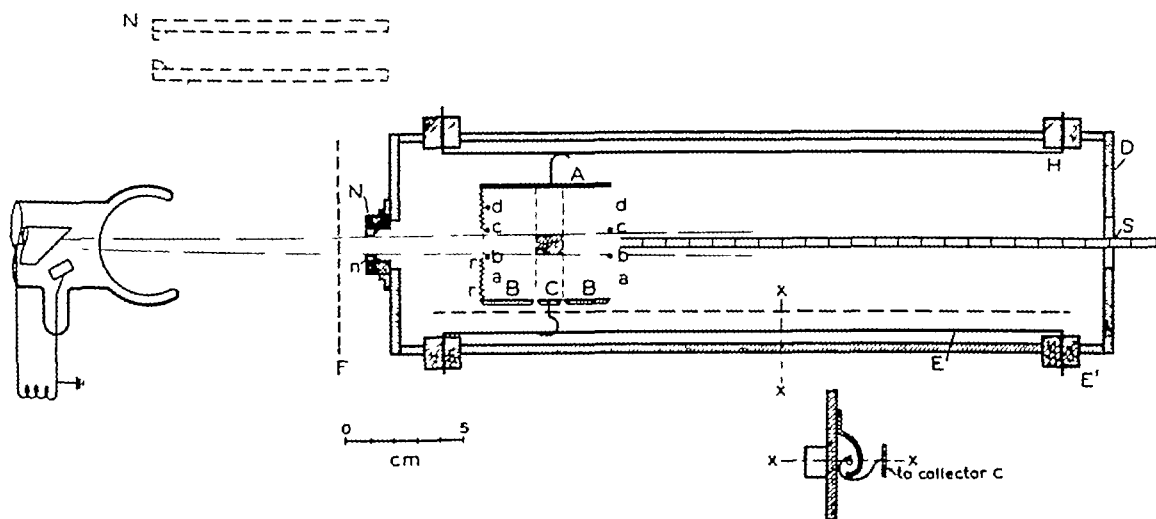


Fig 1 Cross-section of special guarded field ionization chamber for measuring low voltage x-rays (3-80 K V)

steps between zero (at collector) and the plate potential. It has been shown that such a system permits the use of grounded metal parts (case, diaphragm, etc.) much closer to the electrodes than would otherwise be possible. In the present case, the shielding and the limiting diaphragm may be brought to within 5 cm of the center of the collector plate, and air absorption correction need be made for this small distance.

A cross-section of this special ionization chamber for soft x-rays is shown in Figure 1. The electrode system consists of the high potential plate A , the two grounded guard plates B , and the collector electrode C , all mounted as a unit, similar to the larger type of guarded field chamber. The four rectangular guard wire loops, a , b , c , d , made of 10 mil aluminum, are maintained at equal potential steps, respectively, between earth and the potential of A by means of 5 half-megohm resistors, r , r , mounted on a hard rubber supporting frame. The entire electrode system can be slid the length of the box, D , on two guide rods, and its position read on the

The box D , is of $1/8$ in brass, which provides sufficient radiation protection for lower voltage x-rays. For higher voltage x-rays, it is further shielded with about 1 mm of lead. Potential to saturate the chamber is led on to the rod, H , upon which rests a sliding contact connected to A . Similarly the collector electrode, C , is connected by a sliding contact to E which leads to the electrometer system. The rod, E , is shielded over its entire length, as shown by the section X , for the purpose of preventing any ions not formed within the electrode system from reaching the electrometer system. The adequacy of this shielding was tested experimentally.

The diaphragm n , has an 8-mm orifice with the limiting edges, cylindrical and about 1 mm thick. The chamber as a whole is mounted on a base that slides in a direction parallel to the x-ray beam axis. A series of aluminum filters, F , about 3 cm in diameter are mounted on a celluloid disc, the axis of which is independently movable parallel to the chamber's displacement.

A STANDARD IONIZATION CHAMBER FOR GRENZ RAYS

By LAURISTON S TAYLOR and C F STONEBURNER, *Washington, D C*

ABSTRACT

A special type of chamber has been designed to measure the ionization produced by from 3 to 12 K V λ -rays in a known volume of unrestricted air, thus making it possible to express the intensity of the λ -ray beam in roentgens per minute. By the use of a very small guarded field ionization chamber (5×5 cm), the air absorption correction is reduced several fold, and hence errors in its determination are not so serious in the final result sought. It is shown that air absorption corrections must be determined separately for each beam of radiation used, and the chamber is so designed that

the necessary corrections may be determined without recourse to other special apparatus. Examples are given showing in detail the methods of making measurements with the chamber described. Compared at higher voltages (from 40 to 90 K V) with a large primary standard ionization chamber, the small type here described shows a divergence of about ± 0.5 per cent which is believed to be the over all error present in its use. In order to obtain this close agreement, it is necessary to take special precautions in the construction and measurement of the limiting diaphragm and the collector electrode.

I INTRODUCTION

WITH the increasing clinical use of soft λ -rays, excited by potentials of from 3 to 12 K V (peak), arises the necessity for their more accurate measurement such as is obtained with the higher voltage radiations. This is particularly important in view of the fact that such radiation may furnish an erythema dose in one or two minutes. In fact, errors in measurement assume even greater importance than for high voltage λ -rays.

Although several investigators have reported on the measurement of soft λ -rays (so-called Grenz rays), they have given but few essential details of the methods they employed.^{1, 2, 3} This obscurity led us to construct an open-air ionization chamber capable of measuring soft λ -rays, and to compare it with the standard used for measuring high voltage λ -rays.⁴ A

chamber has, therefore, been designed which measures reliably λ -rays excited by voltages ranging from 3 to 80 K V (peak), covering not only the "Grenz-ray therapy" (from 3 to 12 K V) but also the lower "diagnostic λ -ray range" (from 60 to 80 K V).

Open-air chambers lacking a guarded field are not readily applicable to the measurement of soft λ -rays because the large air absorption correction involved cannot be determined with desired accuracy. The principle of the guarded field air ionization chamber⁴ renders it, however, particularly adaptable by permitting the air path between diaphragm and collector plates to be reduced to a minimum. The points essential to its successful application to low voltage λ -rays are worked out in the present investigation.

II DESCRIPTION OF CHAMBER

Described briefly, the guarded field ionization chamber furnishes adequate field uniformity over the width of the collector electrode of a parallel plate ionization chamber, by means of properly

¹ H Kustner *Strahlentherapie* 1928 27, 124

² B Rajewsky and G Gabriel *Strahlentherapie* 1928 30, 20

³ Otto Glasser *Chap III of Grenz ray Therapy* by Gustav Bucky (Macmillan 1929) See also *RADIOL OG*

⁴ L S Taylor and G Singer *Bureau of Standards Jour Research* (RP 211) 1930 5 507

3 *Saturation Voltage*—Voltage to saturate the ionization chamber was supplied from a 1,300 volt d c generator. Curve *A* in Figure 2 shows that saturation was reached at about 300 volts, hence, for normal operation, 500 volts was applied.

4 *Effect of Scattered Radiation*—In chambers for higher voltage x-rays, the limiting diaphragm must be placed at least from 10 to 15 cm from the collector to avoid the influence of x-rays and x-rays scattered from the diaphragm edges. Since the radiation from low voltage x-ray tubes must, in general, be measured so close to their source that a comparatively divergent beam enters the chamber, the customary type of chamber diaphragm is not satisfactory.

The diaphragm placed as shown by *N* in Figure 1 is satisfactory, provided the scattering from its walls is negligible. This was tested by measuring the ionization with the diaphragm in place, then again, after shifting it to the end of a 10-cm extension tube, *N'*, the chamber being shifted so as to maintain the distance from *N* or *N'* to the tube target the same. Correction was made as shown later for absorption in the 10-cm additional air path. Measurements at 40 K V (eff) gave the following results:

Intensity, diaphragm at normal position	0.964 ± 0.0033
Intensity, diaphragm shifted to 10 cm	0.970 ± 0.0027
Difference	0.006

The observed difference being of the same magnitude as the error of observation but in the direction opposite to that to be expected,⁵ it is assumed that the two arrangements give identical results for the comparatively narrow beams used. In other words, the scattering effect from the walls of the diaphragm orifice is negligible.

Use of the divergent beam exposes the guard wires to the direct radiation and this may have a scattering effect. To test for scattering from this source, two strands of 20-mil aluminum wire were suspended,

insulated, in the beam between the 10-mil guard wires *b* and *c*, hence did not influence the field. The following measurements were obtained at 40 K V (peak), with no filtration:

Intensity, wires in beam	0.295 ± 0.0016
Intensity, wires out of beam	0.294 ± 0.0008
Difference	0.001

The difference being of the magnitude of the experimental error, no appreciable effect arises from permitting the beam to strike the guard wires.

5 *Field Distortion*—To determine how close the electrode system may be brought to the front end of the box without introducing appreciable field distortion, x-ray intensities were measured at each of several successive positions of the electrodes with respect to the box front. Curve *B*, Figure 2, shows the observed increase in ionization as the distance from collector electrode to the diaphragm is increased. Beyond 5 cm, further change is only about 0.2 to 0.3 per cent, a magnitude smaller than the experimental error in these particular measurements.

IV COMPARISON WITH STANDARD CHAMBER

The reliability of the special ionization chamber was finally proved by comparing it with the primary standard on the higher voltage radiation. Since it was not feasible to do this directly, the special chamber was compared with a guarded field secondary chamber and this, in turn, with the guarded field primary standard. For the same beam of 70 K V unfiltered radiation, the following measurements show an agreement between the primary and secondary chambers closer than the experimental error.

(1) Primary standard ionization current	0.1315 ± 0.00026
(2) Secondary standard ionization current	0.1316 ± 0.00030
Difference	0.0001

Comparison of the special chamber with the secondary standard was made with

⁵ This is probably due to error in the air absorption correction.

III OPERATION TESTS (CALIBRATIONS)

1 *Collector Electrode*—Since the chamber is so small, it is imperative that its

serious obstacles to accurate current measurements in case, during the compensation of current, it is difficult to hold the collector at zero potential

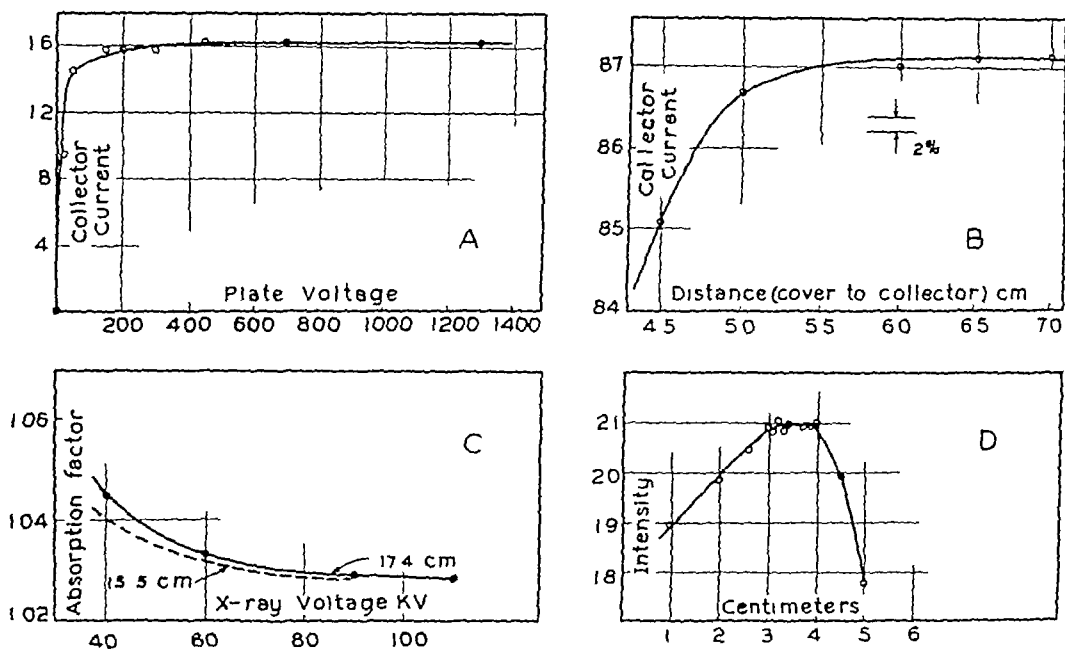


Fig 2 Test curves of ionization chamber

essential dimensions be known with high accuracy. The collector electrode being only about 1 cm wide, along the length of the beam, an error of $\frac{1}{10}$ mm in determining its effective width (true width plus one-half the width of both air gaps between collector and guard plate) would introduce an error of 1 per cent in the effective air volume. The necessity for determining this with accuracy is obvious. Accordingly, through the help of the gauge section of this Bureau, the following typical measurements were obtained:

Width of collector electrode	9.492 \pm 0.005 mm
Separation between guard plates	9.904 \pm 0.005 mm
Effective collector width	9.698 \pm 0.005 mm

Furthermore, to avoid field distortion at the edges, it is essential that the faces of the collector and guard plate lie exactly in the same plane. Field distortion at these edges presents one of the most

2 *Chamber Limiting Diaphragm*—This diaphragm consists of a coin-gold sleeve, n , held in a Pb-Bi alloy ring, N . Its orifice was made and measured in two ways: the first by lapping the inner surface, and then measuring by the plug gauge method, the second by forcing a standard steel ball through an orifice which had been previously turned to a diameter of 1 or 2 thousandths of an inch less than the ball diameter. The latter method burnished the surface and at the same time determined its size. The measured diameters of two such diaphragms were:

Diaphragm 1 (plug gauge method)	7.8608 \pm 0.0001 mm at 68° F
Diaphragm 2 (steel ball method)	7.9375 \pm 0.0001 mm at 60° F

It is seen that the accuracy in determining the diameter by either method is about 1 part in 9,000.

the ratio 0.9698 to 4.975. All readings with the secondary chamber were, therefore, divided by 5.129 to reduce to the same effective air volume as the special chamber.

The distance between the limiting diaphragm and center of the collector electrode on the secondary chamber was 22.5 cm, as compared with 7 cm for the corresponding distance on the special chamber. Absorption in the air path difference of 15.5 cm will, for the same beam, lower the measured current of the secondary chamber relative to that of the special chamber by a corresponding amount. Since this absorption depends upon such factors as voltage wave form, tube characteristic, and tube wall thickness, it must be determined for each set of conditions employed.

At voltages ranging from 40 to 100 K V in which the x-rays pass initially through moderately thick tube walls, the radiation is sufficiently hardened so that its quality undergoes no appreciable further change in passing through 50 cm of air. In such case the air absorption is approximately proportional to the length of the air path.⁹ But, as shown later, this is not true for the 4 to 12 K V radiation for which the special chamber is designed.

Air absorption measurements to be applied in the present comparison were made with the large open-air standard ionization chamber,¹⁰ using the limiting diaphragm in a fixed position relative to the target so as to define a narrow beam passing between the chamber plates. X-ray intensities, I_1 and I_2 , were then measured with the plates at the distances 110.6 and 128.0 cm, respectively, from

the target. The ratio $\frac{I_1}{I_2}$, giving the air absorption correction factor for an air path of 17.4 cm, is plotted against applied voltage in Curve C of Figure 2. The absorption being practically linear with distance, it is simple to correct it to fit any

path length as, for example, 15.5 cm, required in the present set-up and shown by the broken curve.

To insure, in the comparison, proper alignment of the special chamber, measurements were made of the intensity of the x-ray beam over its horizontal cross-section in the plane of the diaphragm, N . As shown by Curve D in Figure 3, the area of effective uniformity, about 1 cm wide, indicates the range of proper alignment.¹¹

Typical results of the comparison of the special with the secondary chambers, with unfiltered radiation from a thin wall, deep therapy Coolidge tube, are given in Table I.

TABLE I—COMPARISONS OF SPECIAL IONIZATION CHAMBER WITH SECONDARY CHAMBER

K V	I_0	I_x	Absorption factor (I_1/I_2) _{15.5}	$\frac{I_0}{I_x} \left(\frac{I_2}{I_1} \right)_{15.5}$
40	4.63	4.46	1.040	0.998
50	2.30	2.205	1.033	1.008
70	2.88	2.79	1.028	1.003
90	6.08	6.08	1.027	0.968

Column 2 gives the intensities I_x in roentgens per minute as measured with the special chamber, Column 3, the intensities, I_x at the middle of the collector, as determined with the secondary standard but uncorrected for air absorption in the extra 15.5 cm of path, Column 4, the corresponding air absorption factor, as obtained from the broken curve of Figure 3C and by which I_x is multiplied in order to obtain the intensity 15.5 cm nearer the diaphragm, at which point the special chamber is used, and the last column gives the ratio of the intensities furnished by the two chambers.

At 90 K V (peak) the small chamber indicates definitely too little ionization. This is attributed to the close spacing (5 cm) of the collector, C , and high potential plate, A , which does not permit full utilization of the range of the photoelectrons.

⁹ L. S. Taylor and G. Singer, Bureau of Standards Jour. Research (RP 271), 1931, 6, 219.

¹⁰ L. S. Taylor, Bureau of Standards Jour. Research (RP 56), 1929, 2, 771.

¹¹ L. S. Taylor, Bureau of Standards Jour. Research (RP 119), 1929, 3, 807.

unfiltered radiation excited by from 40 to 90 K V (peak) To eliminate as many variables as possible, the same diaphragm was used interchangeably on both chambers Likewise, the collector electrode of each

such as was used in previous work,⁷ wherein the ionization charge was compensated over a known interval of time However, instead of exposing the chamber for a given time by means of an electrically operated

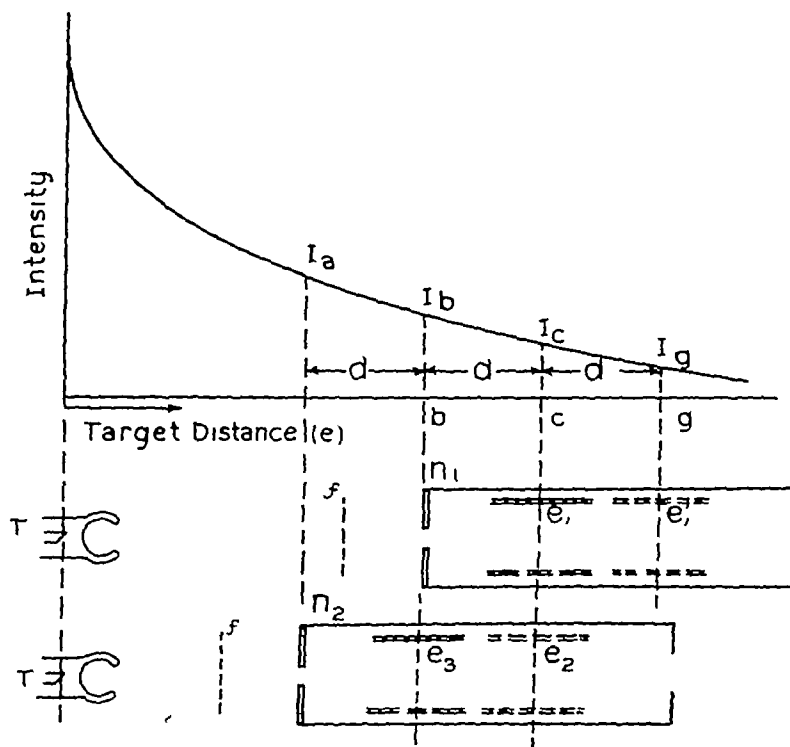


Fig 3 Working positions of ionization chamber

chamber was connected to the same electrometer Saturation voltages were supplied separately Both chambers were placed in a fixed position and the tube shifted on a track, so that the same beam could enter either chamber as desired To have this beam moderately well defined, a diaphragm 16 mm in diameter was placed about 2 cm from the wall of the 200 K V thin-walled Coolidge tube used⁶

Ionization currents were measured by means of a null electrostatic compensator,

shutter in the x-ray beam, the electrometer was connected to the chamber for a definite period by means of an electrically operated switch⁸ located at E' (Fig 1) The chamber and electrometer were connected by a shielded rubber cable

The effective length along the beam of the collector of the secondary standard was 4.975 cm so that, for the same diaphragms, the effective air volumes ionized in the special and secondary chambers were in

⁶ L S Taylor Bureau of Standards Jour Research (RP 56) 1929 2 771

⁷ L S Taylor Bureau of Standards Jour Research (RP 306) 1931 6 807

⁸ L S Taylor Bureau of Standards Jour Research (RP 397) 1932 8 9

TABLE II—AIR ABSORPTION FACTORS
8 K V (PEAK)(Slack window, Grenz-ray tube)¹²

Diaphragm position	Absorption path distance from target	Absorption factor
1 (a-b)	12-18 cm	1.635
2 (b-c)	18-24 cm	1.593
3 (c-d)	24-30 cm	1.576

The letters in parenthesis refer to the positions in Figure 4. The correction factor changes between Positions 1 and 2 by 4.2 per cent, between 2 and 3, due to hardening of the radiation, by only 1.7 per cent. This proves that air absorption corrections made in one position cannot be applied to another position without introducing a corresponding error.

It is also evident from these measurements that, as the distance, d (Fig. 3), of the middle of the collector electrode increases, the absorption correction correspondingly increases and may become so large that its accuracy of determination is insufficient. It is obvious that d should be kept as small as possible. With the chamber used here, d may be as small as 5 cm for radiation up to 80 K V (peak), while, for the same range, a simple parallel plate or cylindrical ionization chamber would have a minimum distance $d = 13$ cm and, therefore, at least double the absorption correction.

Measurements were made using a commercial Grenz-ray generator and a tube with a thin indrawn-bubble type of window¹³ of such size and position that the ionization chamber diaphragm could be brought to about 5 cm of the target. The filament side of the tube was grounded (Fig. 4), and the voltage regulated by means of a slide wire autotransformer T_A in the primary circuit of the high voltage transformer. Peak voltage was determined from the manufacturer's calibration in terms of the voltage, V , on the primary of the transformer. (Since accurate values

of the tube voltage were of no great significance in this particular work, the voltage calibration was not checked.)

Air absorption, expressed in terms of

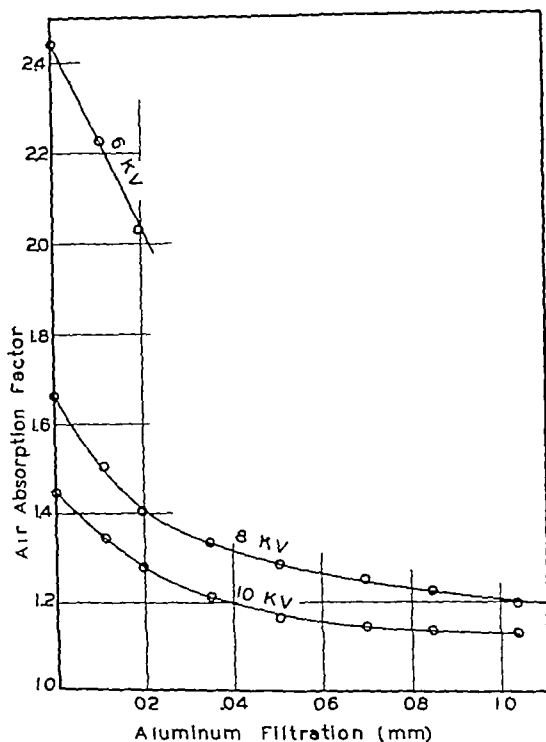


Fig. 5 Air absorption factor for Grenz rays

an absorption factor, I_b/I_c (see Fig. 3), multiplied by the ionization reading, I_c , gives the intensity in roentgens per minute at the point, b , the position of the limiting diaphragm. The absorption factor, I_b/I_c , for $d = 6$ cm is plotted in Figure 5 as a function of the thickness of aluminum filter used in the beam. It is seen that for lightly filtered radiations, air absorption correction may be, with 6 K V radiation, as large as 40 per cent. The need for accuracy of this correction is obvious.

Figure 6 gives a series of curves showing the intensity, I_b , in roentgens per minute at the position $b = 12$ cm as a function of the aluminum filtration. The lower curve of each pair gives the measured intensity while the upper curve gives the corresponding calculated value at the

¹² C. M. Slack, Jour. Opt. Soc. Am., 1929, 18, 123¹³ See footnote 12

emitted along the path of the γ -ray beam. This sets a definite γ -ray voltage limit above which the small chamber should not be used. The safe working range for the present chamber includes, however, the

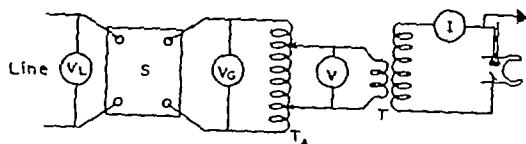


Fig 4 Diagram of power input to Grenz ray tube

lower part of the diagnostic γ -ray region and may be used where, due to "wall effect," measurements with most thimble ionization chambers become inaccurate

V MEASUREMENTS OF GRENZ RAYS

Having found agreement between the indications of the special and the standard chambers at voltages ranging from 40 to 80 K V (peak), the use of the special chamber may be extended down to any γ -ray voltage for which adequate air absorption correction can be made

For measuring so-called "Grenz rays," 4 to 12 K V (peak), the necessary corrections will be indicated and the necessity for accurately measuring the air absorption for each set of experimental conditions under which the radiation is used will be brought out

Very soft γ -rays (4 to 12 K V) are absorbed by air to such a degree that the radiation quality changes rapidly even in a distance of only 5 centimeters. The beam intensity should, therefore, be measured at the exact position, with respect to both tube and filter, where the radiation is to be applied, because it is unsafe to apply the inverse square law for computing intensities at points other than where measured. Furthermore, it is essential to determine the air absorption between diaphragm and collector, C , for an air column having exactly the same position with re-

spect to the target as the column between diaphragm and collector when the chamber is in its working position, if the point of application is taken at the position of the limiting diaphragm

The requirements are illustrated in Figure 3 which gives a plot of the intensity of an γ -ray beam as a function of the distance, e , from the target, T . At the lower part are indicated several possible positions of an ionization chamber with respect to the tube. Suppose, for example, the intensity, I_b , at the position, b , is to be measured. The chamber diaphragm would be placed at position, $n_1 \equiv b$, and the middle of the collector electrode at e_1 , a distance, d , from n_1 , where d is the minimum working distance between collector and diaphragm. Owing to air absorption over the path, $b-c$, the intensity measured at e_1 must be corrected to give the value as if at the position, n_1 . This correction cannot be obtained by simply keeping n_1 fixed, and moving e_1 away an equal distance, d , to the position e_1' because, due to the filtering action of the air, the radiation quality at g is different from that at c .

To obtain the air absorption factor to be applied in the chamber working position, it is necessary to move the chamber, including diaphragm, toward the tube a distance, d , to the position, n_2 , and then measure the intensities, I_b and I_c , obtained respectively at the two positions of the collector plate, $e_2 \equiv n_1$, and $e_1 \equiv e_1'$. The ratio $\frac{I_b}{I_c}$ gives the air absorption factor to be applied to the readings made with the chamber at the position n_1 . Corrections made in this manner are limited to distances, d , or greater, from the γ -ray tube. The special chamber described, owing to its small size, is particularly well adapted to the problem, an unguarded field type cannot be made sufficiently small without introducing too great field distortion

The observed change in the air absorption factor, as the distance from the tube is changed, is given in Table II

CHOLECYSTOGRAPHY WITH TETRAIODOPHENOLPHTHALEIN BY MOUTH, EXPERIENCE WITH REGARD TO SUCCESS AND UNTOWARD REACTIONS¹

By R R NEWELL, M D , and EDWARD LEEF, M D , *San Francisco*

From the Department of Radiology, Stanford University School of Medicine

IN the past five years we have given to 1,257 patients tetraiodophenolphthalein by mouth. In 1,000 of these (80 per cent), the tetraiodophenolphthalein collected in the gall bladder to a visible degree. By chance they were studied in two nearly equal groups. Of 695 cases studied in the first 3 years, 84 per cent visualized, of 562 cases studied in the last 2 years, 74 per cent visualized.

The observed difference between these two samples of cases is more than ten times their standard error. If our technic has not decreased in efficiency, we may suppose that our patients have in later years been more narrowly selected.

TECHNIC

We think that neither catharsis nor enema is a desirable routine in preparing a patient for gall bladder examination. First, two films of the gall bladder region are made, searching for calcified stones. The radiologist sees these films in case any suggestive shadow needs further study, as, for instance, a lateral view. Then (or after the six-hour examination, as in the usual case when the patient is also having a gastro-intestinal study) he is given the following typewritten instructions:

At four o'clock (4 00 P M) drink glass of half milk, half cream. Supper at 8 30, consisting of tea with sugar but no milk or cream, two slices of toast with jam or jelly but without butter, stewed fruit and fresh fruit, baked potato without any cream or butter. Immediately after supper, thoroughly mix the entire bottleful of tetradol into a glassful of grapejuice and drink all of it. If any remains in the bottom of the glass, use more grapejuice to dissolve it. Nothing but water can be had until midnight, and thereafter nothing at all

by mouth. Come to the x-ray department at eight o'clock to-morrow morning, without breakfast.

At 8 A M, a single film is made of the gall-bladder region, at 60 K V, using the Bucky diaphragm. The radiologist looks at the film and if he is dissatisfied with the visualization on this 11-hour film, another is taken (still fasting) at fourteen hours. If still no satisfactory shadow is visible, we usually have the patient repeat the 4-gram dose that evening and return for another 11-hour film and, if necessary, a 14-hour film the next day. As soon as a satisfactory shadow is seen (if ever) the patient is told to eat breakfast (fatty) and return two hours later for a last film.

We wish to lay stress on the desirability of having the radiologist see each gall-bladder film as soon as developed so that any necessary films (lateral or in opposite respiratory phase) may be taken to clear up doubt or suspicion.

For five years we have used the same preparation, namely, tetradol emulsion (National Aniline and Chemical Company)² 4 grams, always drunk in a glassful of Welch's grapejuice.

The intravenous method was originally our routine. Before changing to the oral method as a routine, we gave 31 patients 3 grams of tetraiodophenolphthalein in colloidal suspension (precipitated by CO₂ gas), and then at a later date gave the same patients 2 grams of the same drug in solution intravenously. In two cases, concentration after oral was greater than after intravenous administration, in four cases concentration was the same. In 18 cases, concentration after intravenous was greater.

² Our results do not give information as to which of the commercial preparations of tetraiodophenolphthalein available gives the best results or shows the fewest reactions. Our continued use of the one preparation has been solely in the interests of uniformity.

¹ Read before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.

diaphragm—obtained by multiplying by the appropriate absorption factor from Figure 6. It is interesting to note in this connection that a lateral shift, corresponding to 0.0055 mm thickness of aluminum, of the first curve of any pair brings the two

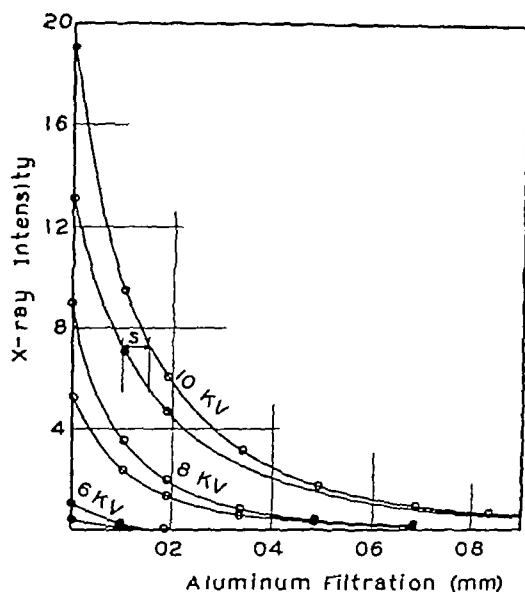


Fig. 6 Ionization intensity curves for Grenz rays

curves together, within experimental error. This means that the absorption of 6 cm. of air is equivalent to 0.00055 cm. of aluminum for the range of voltages and qualities covered in Figures 5 and 6. The aluminum equivalence of air is from this 9.2×10^{-5} mm. Al per mm. of air, which agrees favorably with the value 9×10^{-5} reported by Siegbahn¹⁴ but is appreciably higher than Glasser's value of 7.9×10^{-5} millimeters.

¹⁴ M. Siegbahn, *The Spectroscopy of X-ray* (Oxford) 1925.

The logarithm of the intensity plotted against thickness of filter shows a distinct curvature up to 0.1 mm. Al filtration and indicates that there is no "homogeneity filter"¹⁵ beyond which the quality does not change. Typical examples of intensity and absorption curves for Grenz rays have been given by Jacobson¹⁶ and others. Such curves have value only for a particular tube and should be determined separately for each type of generator, as brought out by using the system indicated in Figure 4. Here tube emission was measured for a constant voltage, V , applied to the transformer, T , and constant current, I , through the tube, the input voltage, V_G , to the control autotransformer being stabilized in one case and unstabilized in the other.¹⁷ The results in Table III show a

TABLE III—GRENZ-RAY EMISSIONS FOR DIFFERENT VOLTAGE WAVE FORMS

Line voltage V_L	Stabilizer	Input voltage V_G	Emission
109	out	109	16.07
104	out	104	16.24
109	in	106.5	8.83
104	in	106.5	8.52

50 per cent decrease in emission with the particular type of stabilization used. Since the effect of wave form on emission varies between tubes of different types, there is little to be gained by further investigation of the variation, it simply emphasizes the necessity for individual measurements with each type of generator used.

¹⁵ H. Behnken, *Zeit. für Tech. Phys.* 1921, 2, 153.

¹⁶ L. Jacobson, *Am. Jour. Roentgenol. and Rad. Ther.* 1929, 22, 547.

¹⁷ All stabilizers of the general type here used produce a distorted wave form in the output depending upon the load power factor. This does not in any way affect their usefulness for their intended purpose.

Davis (1) reported a series of 305 cases showing the incidence of reactions following the intravenous method. His findings confirm our impression, namely, that reactions are definitely less by the intravenous method. Only 75 of his 305 cases suffered reactions.

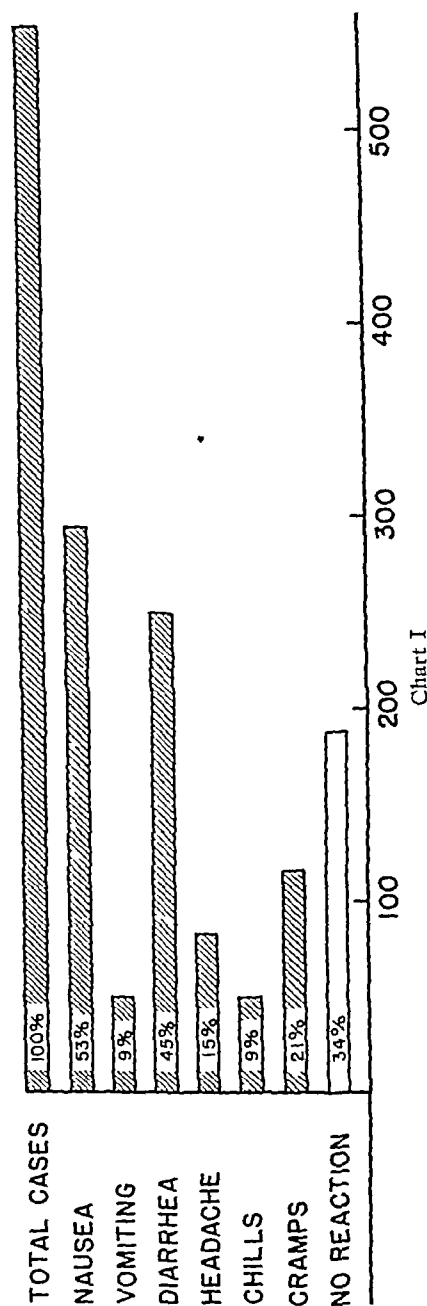
Under the term of "reactions" we have grouped all those unpleasant symptoms that not infrequently follow oral administration of tetraiodophenolphthalein (Chart I). We have recorded these carefully since February, 1931, and present a tabulation only for these later cases. Our data for reactions after intravenous tetraiodophenolphthalein are too few to be statistically significant.

Besides the unpleasantness of these reactions, we have to consider their interference with the success of the test. Chills and vomiting (fortunately not frequent) seem definitely to lessen the chance of success. However, we have seen (2) several cases in which vomiting came within 20 minutes of ingestion, yet was followed by good concentration in the gall bladder. Intestinal symptoms (cramps and diarrhea) do not seem to prevent the absorption of the dye. Our data give us a basis for deciding how worth while are certain details of technique.

Time of the Evening Meal—The tetradol emulsion has always been given about 9 P M. We have 93 cases in which the low fat supper was taken about three hours prior to the dye, and 469 cases in which supper was put off until about 8:30 P M. On the whole, reactions were more frequent in the latter series. The late supper yielded a few more non-visualizations, but tended to a higher degree of concentration in those that did visualize.

If the first film shows no shadow, a second film 3 hours later is of definite value. We found one chance in six that the second film would show a gall-bladder shadow. A second dose of dye given 24 hours after the first dose (which had failed to give a visible gall-bladder shadow) succeeded in bringing up a satisfactory shadow in half of the cases tried. The sight of food does

REACTIONS AFTER TETRAIODOPHENOLPHTHALEIN 4 GRAMS BY MOUTH
SOME CASES PRESENTED MORE THAN ONE SYMPTOM



not in our experience cause the gall bladder to empty. We are reporting this separately (3).

CONCLUSION

A review of our experience in gall-bladder visualization with tetraiodophenolphthalein by mouth convinces us

(1) That as a routine test it is fairly satisfactory (80 per cent visualizations)

TIME RELATION OF SUPPER TO TETRAIODO
EFFECT ON INCIDENCE OF REACTIONS AND ON SUCCESS OF VISUALIZATION

		REACTIONS PER CENT							SUCCESS					DID NOT VISUALIZE
		NAUSEA	VOMITING	DIARRHEA	HEADACHE	CHILLS	CRAMPS	NO REACTION	PER CENT OF CASES ATTAINING OR SURPASSING A GIVEN PERCENTAGE CONCENTRATION IN THE GALLBLADDER					
									2 1/2	2	1 1/2	1	1/2	
EARLY MEAL	93 CASES	28	5	45	14	5	16	35	—	24	29	64	76	24
LATE MEAL	469 CASES	60	10	44	14	10	22	34	7	35	41	60	73	27

Table I

178 CASES IN WHICH FILM WAS MADE 14 HOURS
AS WELL AS 11 HOURS AFTER ORAL TETRAIODO

OBSERVATION AT 11 HOURS		OBSERVATION AT 14 HOURS	
NO SHADOW	102 CASES	1/2 % CONCENTRATION, OR BETTER	17 CASES
		STILL NO SHADOW	85 CASES
1/2 % TO 1 % CONCENTRATION	76 CASES	CONCENTRATION IMPROVED	24 CASES
		CONCENTRATION NO BETTER	52 CASES

Table II

RESULTS OF IMMEDIATE REPETITION OF TESTS

OBSERVATION AT 11 & 14 HOURS	1 ST DAY	OBSERVATION	2 ND DAY
NO SHADOW	27 CASES	2 % CONCENTRATION	10 CASES
		1 %	2 CASES
		1/2 %	1 CASE
		NO SHADOW (at 11 or 14 hours)	14 CASES

Table III

than after oral administration, including three instances in which visualization was obtained only by the intravenous method. There were seven cases that gave no visible shadow at all.

Later, we tried several preparations for oral administration, volunteers taking four kinds at different times. Although this did show us that commercial preparations are better than our CO₂ precipitated dye, yet we believed the intravenous method more dependable. However, the difference was not thought sufficient to outweigh

the advantages of a simpler technic and the avoidance of an occasional thrombophlebitis.

REACTIONS

We are reporting here our study of reactions after tetraiodophenolphthalein by mouth. We have not carried out our original intention of studying a similar series intravenously. We hope that some who are doing this routinely will give us their experiences to compare with our own.

Davis (1) reported a series of 305 cases showing the incidence of reactions following the intravenous method. His findings confirm our impression, namely, that reactions are definitely less by the intravenous method. Only 75 of his 305 cases suffered reactions.

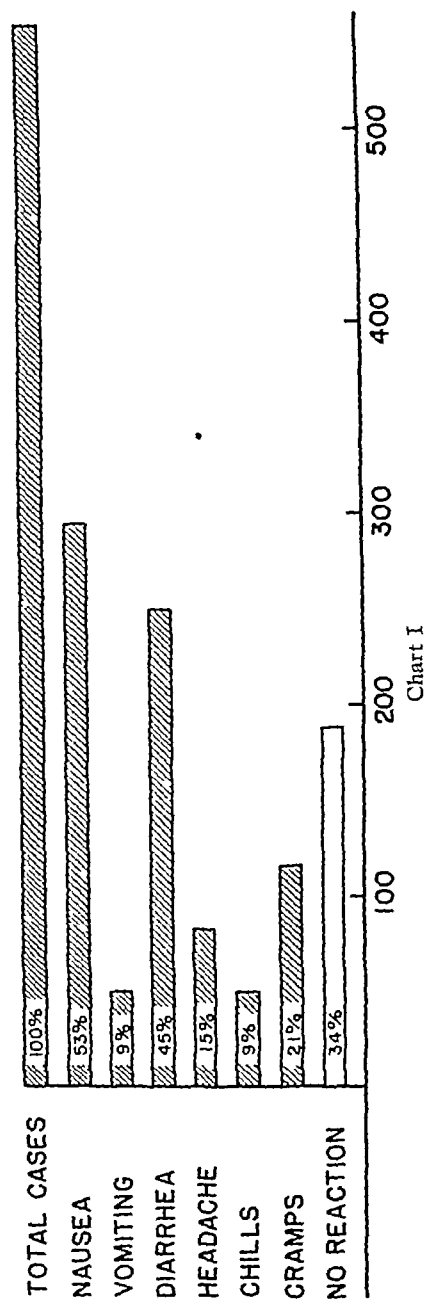
Under the term of "reactions" we have grouped all those unpleasant symptoms that not infrequently follow oral administration of tetraiodophenolphthalein (Chart I). We have recorded these carefully since February, 1931, and present a tabulation only for these later cases. Our data for reactions after intravenous tetraiodophenolphthalein are too few to be statistically significant.

Besides the unpleasantness of these reactions, we have to consider their interference with the success of the test. Chills and vomiting (fortunately not frequent) seem definitely to lessen the chance of success. However, we have seen (2) several cases in which vomiting came within 20 minutes of ingestion, yet was followed by good concentration in the gall bladder. Intestinal symptoms (cramps and diarrhea) do not seem to prevent the absorption of the dye. Our data give us a basis for deciding how worth while are certain details of technique.

Time of the Evening Meal—The tetradol emulsion has always been given about 9 P. M. We have 93 cases in which the low fat supper was taken about three hours prior to the dye, and 469 cases in which supper was put off until about 8:30 P. M. On the whole, reactions were more frequent in the latter series. The late supper yielded a few more non-visualizations, but tended to a higher degree of concentration in those that did visualize.

If the first film shows no shadow, a second film 3 hours later is of definite value. We found one chance in six that the second film would show a gall-bladder shadow. A second dose of dye given 24 hours after the first dose (which had failed to give a visible gall-bladder shadow) succeeded in bringing up a satisfactory shadow in half of the cases tried. The sight of food does

REACTIONS AFTER TETRAIODOPHENOPHTHALEIN 4 GRAMS BY MOUTH
SOME CASES PRESENTED MORE THAN ONE SYMPTOM



not in our experience cause the gall bladder to empty. We are reporting this separately (3).

CONCLUSION

A review of our experience in gall-bladder visualization with tetraiodophenolphthalein by mouth convinces us

(1) That as a routine test it is fairly satisfactory (80 per cent visualizations)

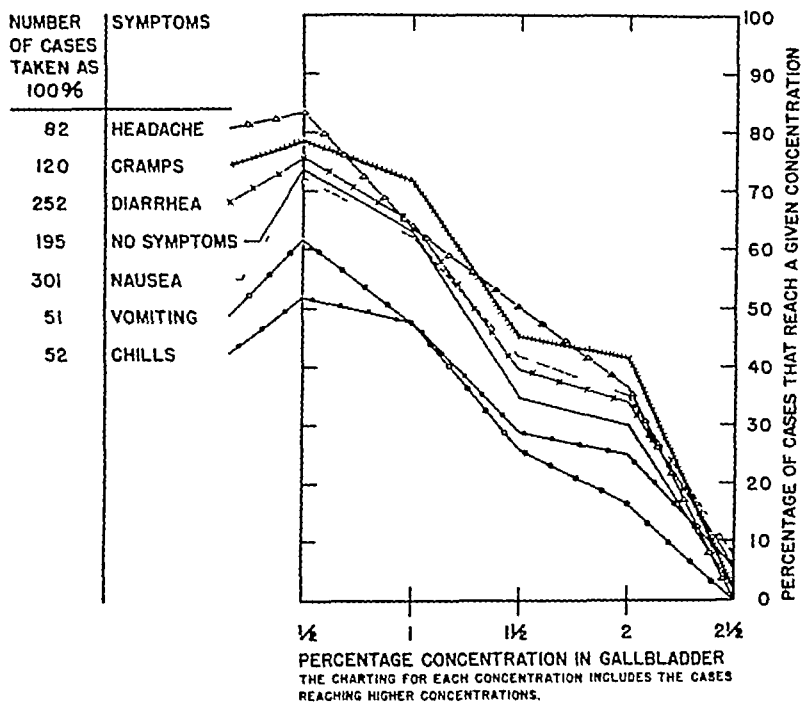


Chart 2

(2) That reactions are frequent and may be distressing we have seen none that seemed dangerous

(3) Reactions have comparatively little influence on the success of the test

(4) A single careful film is sufficient, however, if on the failure to obtain a satisfactory shadow, a second film is taken three hours later

(5) Such a second film will succeed in one-sixth of the cases tried

(6) Failure to get a good shadow should lead one to repeat the dose at twenty-

four-hour intervals This succeeded in half the cases tried

(7) Sight and smell of food have no influence on the emptying of the gall bladder

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PHYSIOLOGY OF THE GALL BLADDER CHOLECYSTOGRAPHY SHOWS NO PSYCHIC EMPTYING¹

By EDWARD LEEF, M D , *San Francisco*

From the Department of Medicine, Stanford University School of Medicine

IT has long been known that chyme, especially fatty chyme, on entering the duodenum causes the gall bladder to empty. Ivy and Oldberg (1), in 1928, showed that the mechanism for this stimulation is *via* the blood stream and named the mediator cholecystokinin. Boyden (2), in 1928, showed in several instances that there was a slight response to the smell of food, but that the amount of bladder bile released was negligible. Sandblom (3), in 1933, observed gall-bladder contraction after human subjects had received blood transfusion from donors recently fed egg yolks. Puestow (4), in 1931, showed in dogs a slight flow of bile at the smell of food. We wished to know if "psychic stimulation" might be affecting our routine tetraiodophenolphthalein tests in man.

We did this in the following manner. If we found two patients the same morning

whose gall bladders were filled with a good concentration (2%) of tetraiodo, these two were sent together to the diet kitchen where one would watch the other eat an appetizing breakfast consisting, among other foods, of bacon and eggs, but would himself eat or drink nothing. Both would then return for another film. The fasting one would then go to his breakfast and return for a third film. We tried six such pairs. In all cases the gall bladder failed to empty in any perceptible degree at the sight and smell of food, but did subsequently empty after actually eating the food.

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¹ Read before the American Congress of Radiology, at Chicago Sept 25-30 1933.

ROENTGEN-RAY BURNS

WITH REPORT OF NINE CASES FROM UNIVERSITY HOSPITAL, PHILADELPHIA, 1907 TO 1933

By GEORGE S ZUGSMITH, M D , *Pittsburgh, Pa*

THE story of the dangers and untoward results of x-ray radiation and radium emanations is one of the bravest yet saddest tales of modern medicine. It has been a long time since 1896 when Marcuse (1) reported a case of dermatitis attending the use of roentgen rays, and a malignancy on an old x-ray dermatitis. The knowledge of prevention of burns has advanced greatly since then, but it was only recently, 1928 in fact, that Posey (2) reported two cases of deep burns of the throat resulting from x-ray treatments, lasting from 10 to 15 minutes, which were administered by the physician, or his son, and when neither of them could give the treatment, by the colored maid. As to etiology, Lossen (3) recognizes three different kinds of burns: primary burns, as a result of technical errors, secondary burns, as a result of cumulative effects (endogenous causes), and those resulting from a combination of outer circumstances. Porter (4) groups his cases more specifically: lesions resulting from a single massive dose, intentional or otherwise, or a few exposures at short intervals, cases with chronic diseases (pulmonary tuberculosis, lupus, psoriasis, eczema) and treatment of malignant disease with many exposures over a long period, professional roentgenologists, many of them physicians, who used roentgen rays before knowing their dangers and the proper precautions, or without exercising the latter.

ETIOLOGY

It has been generally agreed that there is no idiosyncrasy to roentgen rays. Del-Buono (5) said: "The pathological phenomenon of idiosyncrasy occurs for minimal doses of the drug or element which brings it about, and its effect, in the organism in general, is manifested by a shock

Feeble doses of x-rays should then produce skin lesions which should result in severe burns, ulceration, and extensive necrosis." It must be acknowledged, however, that there is a definite variation in the susceptibility of the skin of a degree too small to be idiosyncratic. Bergonié (6) spoke of the state as one of indirect or physical anaphylaxis. Wintz (7) showed that healthy skin does not show variation of more than from 10 to 15 per cent in its reaction to x-ray, although damaged skin or general disease may increase the sensitivity. Persons already in a toxic condition are more prone to manifest acute constitutional symptoms than are healthy individuals. Davis (8) showed that syphilitics and cases with Bright's disease do not react favorably to the x-ray. Figg (9) stated that the type of person most susceptible to the x-ray was one with a fair and ruddy complexion, red hair, and a thin dry skin. Desjardins and Smith (10) thought that the degree of exposure required for irritation depended upon

- (1) The complexion of the individual, and his natural pigments,

- (2) The part of the body (thickness of the skin and the number of cell layers),

- (3) The metabolic state of the skin as affected by circulatory and nervous activity

They believed that areas of increased heat and moisture such as are present in the axilla, groin, perineum, and fatty folds in the obese, were more sensitive. The use of certain chemicals on the skin, such as iodine, scarlet R, mercury, pyrogallol, acid, cantharides, resorcin, beta-naphthol, tar, iodoform, sulphur, and salicylic acid, also raised sensitivity. Martin and Caldwell (11) found that other factors influencing the sensitivity were menses, pregnancy, diabetes, arteriosclerosis, gout, ca-

chetic states, injuries, age of the patient, area of the body exposed, local anemia, dryness of the skin, acidity of the sweat, and cutaneous vasomotor irritability Del-Buono (5) reported a case in which a knee wrongly diagnosed as tuberculous was irradiated a burn developed, and a histologic examination disclosed an old trichinosis

Sampson (12) believed that the sensitivity was due to differences in skin temperature He based his conclusions on the occurrence of burns in the folds of the axilla, etc., in the obese, and on the severe reactions obtained following the application of ice-bags to a part after irradiation In some experiments on rabbits, with suitable controls, Martin and Caldwell (11) applied adhesive tape to an area shortly after irradiation and ulceration resulted They ascribed this ulceration to the higher skin temperature under the tape—moisture as a factor was ruled out since rabbits do not perspire Rabbits, following irradiation, similarly exposed to cold by means of ice-bags also had ulceration Other writers showed that it was the amount of blood in the tissues that determined the sensitivity and, therefore, not the temperature *per se*, but the hyperemia produced by the temperature changes which caused the ulceration DelBuono (5) showed that the less blood contained in the tissue, the less will be its sensitivity, and that an injection of adrenaline, causing capillary constriction, raised the ability of the area to withstand the ray

GROSS PATHOLOGY

Highman and Ruhson (31) thought that x-ray produced a series of events paralleling scleroderma The types of pathology from the work of Desjardins and Smith (10) and Davis (8) lend them to a grouping as follows

First Degree—Depilation and tan pigmentation occurs within from 10 to 20 days following the exposure, and ends in desquamation Repeated burns of this degree lead to chronic radiodermatitis in

which there is a dryness of the skin with a tendency to cracking, atrophy telangiectases, permanent alopecias, and keratoses

Second Degree—Erythema appears in from 7 to 14 days, and there is exfoliation lasting from one to three weeks Vesiculation occurs, and the epidermal covering of the vesicles separates The erythema shades off to bronzing and leads to atrophy after from one to three years If the doses are repeated, they may lead to subcutaneous edema and a dense, brawny induration

Third Degree—Practically all of these burns are the result of gross errors in the estimation or administration of the dosage Evidences of extreme irritation may appear within two or three days and, after passing through short stages of erythema and vesiculation, proceed to the point of ulceration The burned area is often tightly adherent to the underlying tissue and may be somewhat depressed There are usually patches of keratoses and one or more chronic ulcers which may be superficial or may involve the full thickness of the skin and also a considerable portion of the soft parts Some heal and then break down again, while others never heal without surgical intervention The healed or un ulcerated portions are hairless and atrophied, wrinkled or smooth, usually dry, shiny, and have a blotchy, brownish-blue pigmentation The subcutaneous fat may be completely destroyed, the muscle may be infiltrated or entirely replaced by scar tissue, and there may be necrosis of the underlying bone The ulceration is limited either wholly or on one or more of its sides by a relatively sharp outline corresponding to the area exposed The edges of the ulcer are thickened, hard, grayish-red, and frequently everted Its surface is covered by a grayish, necrotic layer, and sero-purulent exudate The natural tendency to repair is held in abeyance and, in some cases, the involved area may remain intact for a long period without breaking down, but if traumatized, small ulcers develop and gradually extend to the margins of the field According to Fouts (14),

disintegration and sloughing, once having begun, will continue until a point is reached where there is a sufficient blood supply to maintain life in the tissues. Even beyond this point there is much fibrosis and the tissues are badly crippled.

MICROPATHOLOGY

The action of radiation on cells appears to demonstrate to Mitman (15) that if the energy of radiation is sufficiently great all cells are destroyed, though not necessarily at once, if the radiation is less intense, only the more sensitive ones are destroyed (*Supra*, Michael *et al*). If an important function is destroyed, the cell ages rapidly, if only inhibited, the life of the cell is shortened. Even if there is no apparent inhibition of function, there may still be some slight damage. In radiodermatitis, the ulcerated area is surrounded by a zone of inert but living cells which, having lost their ability to multiply, cannot participate in the process of repair, hence the intractability. DelBuono (5) believes that the capillaries of the corium are affected by very small dosage. The first consequence is the loss of elasticity, so that the vasomotor apparatus no longer functions well and the skin is handicapped in its power of resistance. For larger doses, the lumen of the capillaries becomes smaller, even to obliteration, or an extravasation may occur, with subsequent telangiectasis. Duerck, quoted by Matas (16), believed that the underlying pathology was a progressive, proliferative endarteritis, obliterating the arterioles of the derm and subdermal connective tissue, leading to a gradual but fatal ischemia and nutritional disturbance in the radiated field. Whether initiated primarily in the endothelium of the arterioles, or secondary to correlated changes in the perivascular connective tissue, is not fully determined, but the latency is explained by endothelial proliferation. Cole (17) found the specific changes to be (1) smooth muscle swollen, due to vacuolation and distention of the cells with hyaline

material, (2) blood vessels obliterated, (3) capillaries showing telangiectases, (4) in the hands, the bones show absorption of osseous tissue of the whole or part of the terminal phalanx. There is swelling of the collagen, in the corium, subcutaneous tissue, and walls of the blood vessels, as shown by Wolbach (18, 30). This altered connective tissue does not regenerate, but new connective tissue is laid down by surviving or ingrowing fibroblasts, and this is the process that leads to the shrunken, indurated condition of chronic x-ray dermatitis, and accounts for thickening of the blood vessels. Skin and experimental tissues show swelling of cells and mitotic division on about the fourth day, and in the superficial layers there is a polymorphonuclear reaction to actual necrosis. The human changes are (1) complete loss of the appendages of the epidermis, (2) replacement of the normal collagen by a peculiarly dense hyaline collagen, rich in elastic fibers and poor in cells, (3) obliterative processes in the blood vessels of the corium and subcutaneous tissues, (4) necroses of varying size in the corium, immediately beneath the epidermis, in the earlier stages around thrombosed telangiectases (in the later stages these telangiectases may be nearly absent), (5) response to necroses by reparative proliferation of a part of the epidermis. The immediate, initial change is a focus of localized edema beneath the epidermis. The epidermis becomes separated from the viable corium by an edematous layer which contains only necrotic cells which is often infiltrated with fibrin. There is practically no attempt at repair by the organization of these minute subepithelial necroses owing to the pathologic condition of the deeper-lying connective tissues. The gap is speedily covered by the regeneration of the epidermis so that the effect of the occurrence of these necroses is to produce a downward migration of the epidermis. This epidermal proliferation is not supported by corium, since the corium is destroyed. This sustained proliferation, for many years in contact with an abnormal supporting tissue, Wol-



Fig 1 The focus of localized edema below the epidermis, the round-cell infiltration, and the disarrangement of the corium characteristic of the lesion

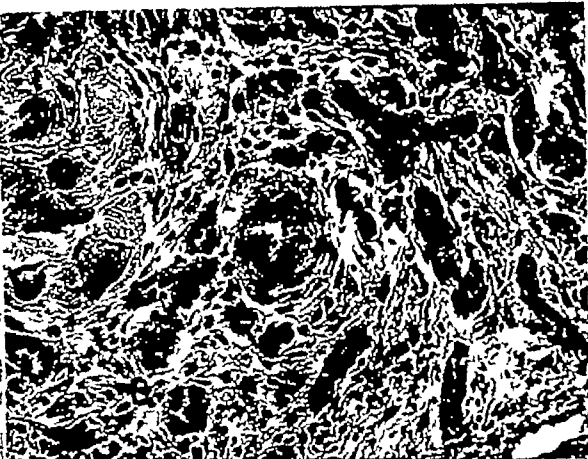


Fig 2 An obliterated arteriole and what begins to look like nests of cells

bach believes may be the development of carcinoma

SYMPTOMATOLOGY

There is usually a period of incubation of the burn during which no effects are manifest although, in some of Pfahler's cases (19, 20, and 21) of abdominal burns, nausea and vomiting were observed within a few minutes after exposure. In cases of x-ray dermatitis among professional men Cole (26) found (1) that there are no symptoms for an indefinite period, (2) that the hands become dry, and there is a loss of the touch and temperature sense, (3) the grip is weakened, (4) there is pain, especially at night, sufficient to prevent sleep. In the first degree burns, there is depilation, burning (occasionally severe enough to be called pain), atrophy, and telangiectases. The second degree burns, in which the pain is much more severe, show the above symptoms intensified, vesiculation, and also there is present a raw sensation. In burns of the third degree, all of the symptoms are still so much more pronounced that there is loss of function and finally actual necrosis. The pain in this type is intense, making morphine addicts of some of the patients, and it is believed to be due to (1) irritation of the nerve endings by infection, (2) changes in the nerves caused by rays, or progressive

obliteration of the blood vessels, (3) pressure on the nerves by the scar. Davis (22) believed that one or all of these were the cause. Occasionally there may be marked subcutaneous edema and ankylosis if the burn has affected the jaw or knee as in cases of Bevan (13) and New (24). Many of the burns produce loss of function by pain or swelling, and, in burns of the anus, this loss of function may produce a variety of additional subjective symptoms. Since the burns produce so much disfigurement and scarring, nervous symptoms are fairly common. A profound neurasthenia may develop. Michael (25) says that x-ray burns are cosmetically offensive, may give rise to distressing subjective symptoms, may disturb function, and are potentially malignant.

TREATMENT

Some writers prefer the use of actinic or ultra-violet light in the active treatment of roentgen-ray burns, but the majority feel that this form of treatment has little or no value and that, since the original damage is a proliferative endarteritis, further irradiation will only aggravate the condition. The delay necessitated by such treatment causes much unnecessary pain and may give sufficient time for the beginning of malignant degeneration. The cases of New (24), Porter (4), Davis (8), Cole (17),

disintegration and sloughing, once having begun, will continue until a point is reached where there is a sufficient blood supply to maintain life in the tissues. Even beyond this point there is much fibrosis and the tissues are badly crippled.

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patient had burns of the anterior surface of the chest and lower part of the neck. Seven years before she had had x-ray treatments for Hodgkin's disease, one treatment daily for a month and two treatments a week for two years. About five years prior to her admission to the hospital, her chest began to blister. There was intense pain, itching, and the skin of the chest was red and hard. Following the cleaning of her chest wound, and a graft on Nov 12 which seemed to take, the patient was discharged, having improved considerably.

Case 3 E C T, male, 40 years of age, was admitted on March 15, 1919, and discharged on April 17, 1919 (33 days). The patient had an x-ray ulcer of the back. On Jan 10, 1919, he had had a gastrojejunostomy, following which he had prolonged fluoroscopic examinations. An ulcer developed and gave pain of an intense character which could be quieted only with heroin. On March 21, 1919, the ulcer was excised, and his recovery was uneventful.

Case 4 R W, female, 37 years of age, was admitted on Jan 5, 1927, and discharged on May 5, 1927 (120 days). Following a complaint of excessive bleeding at the time of her periods, the patient was given two deep exposures of x-ray to the abdomen which lasted 25 minutes each, a treatment which caused nausea and vomiting. Two weeks later, she was given one treatment to her back which lasted an hour and a half. Two weeks later she began to have itching of the skin, a mahogany color, and sloughing. The pain was so severe that heroin in quite large doses was required. Butescin pictrate relieved the itching. An Alpine lamp (used in 1926) caused irritation and fever. On admission to the hospital, the ulcerated area was about 15 cm in diameter. Dakin's solution, phenol dressings, and mercurochrome, 1 per cent, were used to cleanse the wound. On Jan 8, Jan 13, and Jan 20, 1927, skin grafts were taken from the thighs. An infection developed and saline dressings were employed. In

seven months, four débridements were done upon the ulcer on the back. The patient was given phenol ointment for the relief of pain locally. On March 1 and March 19, 1927, Thiersch grafts from the thighs were done, and on April 8 and April 11, 1927, pinch grafts were done. An infection of the area (believed to be *Bacillus pyocyaneus*) hindered the success of many of the grafts. On April 27 and again on May 5, 1927, other grafts were done, which covered all but a small area and which took successfully, the patient being sent home greatly improved and with no pain.

Case 5 J P, male, 24 years of age, was admitted on April 25, 1927, and finally discharged on Oct 27, 1927, a total of 118 days. Between these dates, he had been re-admitted twice. Following a treatment course for eczema five months before admission, a second degree burn had developed, which had healed and sloughed out. There were contractures and the wound was very tender, being especially painful when the patient was walking. The sloughing in the affected area had exposed the tendon. On May 12, 1927, a débridement was done to relieve the patient, who suffered considerable pain. Following this, he was treated with Dakin's solution, antiphlogistin, and boric acid, with no improvement. Curettement was then advised. On June 30, 1927, a large skin flap, three inches in diameter, the upper end of a Gillies tube graft, was attached, unsuccessfully. Ultra-violet radiation was recommended, but this resulted in no improvement. On Sept 10, 1927, a skin graft of the Reverdin type was done, and two days later, the femoral artery was exposed and stripped of the sympathetic nerve fibers. On Oct 18, 1927, six small pinch grafts were applied to the involved area, which took successfully. Bier's hyperemia was suggested, and applied without much success. On his discharge, the patient still had a chronic ulcer.

Case 6 J P L, male, 37 years of age, was admitted on May 17, 1929, and discharged on May 26, 1929, a period of 9

Blair (32), Desjardins and Smith (10), Barrow (33) and others, show that the type of treatment generally used for roentgen-ray burns is palliative until surgery is required or thought indicated. In the less severe burns and the early stages of the severe third degree burns, many lotions and ointments have been tried, most of them with little success. Dodd's solution, made up of phenol 1.85 c c, zinc oxide 15.5 gm, glycerin 4 c c, and lime water to make 250 c c, has been found to give some relief when daubed on with cotton and left to dry. No caustics, irritants, or antiseptics are indicated unless there is a severe infection and then hot saline compresses may give much relief and improve circulation. A useful measure in first degree burns is the spraying on of paraffin films or mixtures such as balsam of Peru 4 c c, castor oil 2 c c, Venetian turpentine 2 c c, and alcohol to make 100 cubic centimeters. To remove sloughing and necrotic tissue from an ulcer, Dakin's or hychlorite solution 1/20 or 1/30 is recommended. The hychlorite is believed to be superior because of its more constant chemical qualities. For recalcitrant lesions, surgery must be undertaken. Porter and White (26) feel that all ulcerations which, under ordinary treatment, remain open after three months should be thoroughly excised and very carefully examined. The subsequent treatment depends on the result of the microscopic examination: there should be skin grafting, further excision and grafting, or amputation. Keratoses should be removed by electro-dessication or coagulation. In excision of a burned area, one must go beyond the visible limits of the burn, since much of the damage is microscopic and extends further than one is led by gross inspection to believe. Wide excision is the only sure way of relieving the pain. Skin grafts should be applied to the excised area immediately, if there is a certainty that all damaged tissue has been removed. If doubtful tissue is left, owing to the impossibility of complete excision due to its involving nerves, arteries, tendons, or the whole thickness of the

abdominal or chest walls, the grafting should be deferred until there are granulations. The type of graft used is determined largely by individual experience. New (24) feels that the tube flap gives a better cosmetic result and better color than the full thickness graft. Bevan (23) uses primary excision and closure in acceptable cases, such as in burns of the anus. Reverdin, Thiersch, full thickness, and flap grafts have been used by different men with good results.

PREVENTION

In the prevention of x-ray burns, Davis (27) recommends. The further education of those using the x-ray as to its dangers, a better protection for the patient and the operator, and education of the public. There should be a limitation of the indiscriminate sale of x-ray machines and apparatus, as many burns have occurred (Hazen, 28) from their use in beauty shops. Pfahler (19) and Tousey (29) stress careful measurement of timing, notice as to milliamperage and filtration, detailed and complete records, a device to prevent the omission of the filter, and attention to the fact that patients be reminded not to use irritants following the x-ray. For roentgenologists, the carrying of an unexposed dental film in the pocket for two weeks at a time is recommended to determine if their protection is adequate.

The following group of cases of x-ray burns were referred to the surgical service of the University Hospital during the period from 1907 to 1933. None of these cases received roentgen therapy or diagnostic irradiation at this hospital.

Case 1 W C E, was admitted on Aug 29, 1907, and discharged on Oct 16, 1907. The patient was diagnosed as having x-ray burns of the hand, and gave symptoms of pain, deformity, and loss of function. After amputation of a finger, the condition improved.

Case 2 M T, female, 30 years of age, was admitted on Nov 11, 1918, and discharged on Nov 20, 1918 (9 days). The

take well, but became black and gangrenous at its margins, though the rest of the flap, at the top of the wound, did well. Below this area the wound sloughed out and showed unhealthy, necrotic margins, with a fibrous, white, and avascular base. Very little granulation seemed to take place over this area and pain was still present to a marked degree. This was the condition at the time of the writing of this paper.

All of them had pain as the most prominent symptom, loss of function and disfigurement being the next symptoms of importance. A long series of exposures caused five of the burns, while three of the others were due to a single great over-exposure. In seven cases, palliative measures were tried before surgery, with poor results. In two cases ultra-violet light was used with no result. In one case there was a severe reaction to this form of treatment. The result of surgery was clinical cure in seven cases. In one of the others, the result was improvement, and in the other malignant degeneration had occurred before the ulcer was treated. The type of surgery used was excision and

Thiersch grafts in three cases, excision and Reverdin grafts in two cases, excision and full thickness graft of the flap type in two cases, and amputation in two cases. The average number of days of hospitalization was 39, a figure which is necessarily low because of the nine patients—four were treated in other hospitals after their discharge. The surgery used must depend largely on the location of the burn, looseness of adjoining tissues, thickness of the tissues, and the blood supply.

I would like to thank Dr I S Ravdin of the University of Pennsylvania, without whose assistance and advice this paper would not have been completed.

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TABLE I—CHART OF ALL CASES TREATED AT UNIVERSITY HOSPITAL FROM 1907-1933

Case	Sex	Age	Etiology of burn	Location	Treatment	Result	Hosp days
W C E	Incomplete records			Burn of hand	Amputation of finger	Good	19
M T	Female	30	Treatment for Hodgkin's disease	Ant surface of chest and neck	Excision of ulcer Reverdin graft	Good	9
E C T	Male	40	Fluoroscopic examination	Ulcer of back	Excision	Improvement	33
R W	Female	37	Profuse menorrhagia	Ulcer of back	Excision of ulcer Thiersch graft	Improvement	120
J P	Male	24	Treatment for eczema	Left popliteal space	Débridement and Reverdin grafts	Result poor	118
J P I	Male	37	Fluoroscopic removal of foreign body	Base of 3rd 4th and 5th fingers	Amputation	Good	9
R W	Female	43	Treatment for fibroids	Ulcer of abdomen	Excision and Thiersch grafts	Improvement	30
J G	Male	52	Treatment for psoriasis	Ulcer of chest	Excision and Thiersch grafts	Carcinomatous degeneration	24
H D	Male	23	Fluoroscopic removal of foreign body	Lateral aspect of right knee	Excision—full thickness flap graft	Improvement	86 to date

days plus hospitalization at another hospital. Seven months before admission, the patient had run a needle into his palm. X-ray films were made and fluoroscopic removal was attempted for seven or eight minutes, at a distance of six inches. Two more roentgenograms were taken and the fluoroscope was again applied for from three to four minutes. Five days later, the hand began to swell, broke down, and discharged pus. A chronic ulcer developed over the base of the third, fourth, and fifth fingers. On May 18, 1929, a débridement was done and the involved section showed a chronic ulceration, with granulation and necrosis, also considerable epithelial hyperplasia at and beyond the edges of the ulcer. There was no true malignancy. Dressings of mercurochrome, 2 per cent, and Dakin's solution were tried. The patient was discharged at his own request on May 26, 1929. A follow-up note on Aug 18, 1929, stated that he had gone to a hospital in New Jersey where an amputation was done, leaving only the thumb. The wound had healed, and he had no pain.

Case 7 R W, female, 43 years of age, was admitted on June 16, 1931, and discharged 30 days later. Seven years previous to her admission to the hospital, the patient had had roentgen-ray treatments for fibroids, which lasted about a year. Three years before admission, a large blood vessel broke in the affected area, and she has had severe burning pains and a small ulcer on the abdomen, about the size of a ten-cent piece. A wide excision was done and five pieces of skin from the right thigh were grafted onto the involved area. These sloughed out, but a second graft was done which proved to be more successful. On discharge from the hospital, the patient still had a very small wound.

Case 8 J G, male, 52 years of age, was admitted on Nov 24, 1931, and discharged on Dec 18, 1931, a total of 24 days. The patient had had psoriasis for 21 years prior to his admission. Seven years before his admission, he had x-ray and lamp treatment for three years. Following the last

treatment an area of "scorching" was present on his chest. This area was tender and painful and later became ulcerated. It healed to about the size of a quarter but would break down following any trauma. After a slight trauma five months before admission the ulcer broke down and became about the size of an orange. There was much pain—even the touching of the ulcer by the clothing caused discomfort and a sero-sanguineous discharge. The patient was treated by a wide excision of ulcer and scar from his chest and one week later a Thiersch grafting was done. The wounds were dressed with white vaseline gauze which had previously been irradiated under a Mercury Arc Light for one and a half hours at a distance of eight inches. The majority of the grafts had taken at the time of discharge. Six months later, the ulcer which biopsy had proven to be spinocellular carcinoma had broken down again.

Case 9 H D, male, 23 years of age, stated, upon his admission to the hospital, that eight months previous a small piece of steel entered his knee region. It was located under the fluoroscope and removal was attempted at the time. The patient further stated that he was in the fluoroscopic room for about an hour and a half. About a week later, the skin began to darken as if sunburnt. It then became sore, the skin pores turned purple, vesicles formed, and an area about four inches in diameter sloughed out. It is healed up to about one inch in diameter but has sloughed out again. Almost all types of ointments have been used without success. The patient had been treated in the hospital with wet sulphur dressings, alternating with boric acid dressings. A radical excision was done on Feb 11, 1933, leaving a fairly healthy granulating base. The wound was dressed and the edges were protected with paraffin gauze. Three days later a full thickness skin flap was patterned on the thigh above the ulcer, to be turned down in about five days, and on Feb 18 this flap was brought down over the upper half of the ulcer. It did not

A ROENTGENOLOGIC CONSIDERATION OF THE ARTHRITIDES

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ARTHRITIS may be defined as a generalized disease, with joint manifestations. No single infectious or traumatic condition may cause this disease, no metabolic disturbance, but some variation of all these may combine to be a factor in its causation.

Much confusion is apparent in the terminology in that "degenerative arthritis" is also described as "hypertrophic," and "proliferative" is designated as "atrophic." This contradiction is due to the fact that one group bases terminology on changes in soft parts, whereas the other group bases it on bone changes.

Before dealing with the pathologic processes which involve the joint, we might well remember its normal parts, namely, its articulating surfaces composed of cartilage, the synovial membrane, synovial fluid, and ligaments. Neither periosteum nor free bone is normally found in a joint. The diagnosis of a joint condition is accomplished by carefully considering the changes in one or more of its component parts, of which the cartilage is probably the most important. The various chronic conditions met with in arthritis are due mainly to the involvement of the cartilage.

Many infectious types of arthritis seem to involve the synovial membrane, with increased changes in the amount of synovial fluid. In these types of joint infection a return to the normal condition may be reasonably hoped for, while, when the cartilage is involved, the return to normal condition depends largely upon the degree of severity of the infection. It is known that cartilage reproduces itself to a limited degree only, and if a portion is completely destroyed down to the

bone, Nature replaces it either with fibrous or osseous tissue. It is in this manner that what may be called "free bone" in a joint is developed.

For a roentgen consideration of the arthritides, we will classify arthritis as to

- I Traumatic Type
- II Infectious Type
- III Atrophic Type
- IV Hypertrophic Type

I Traumatic Type—This type exhibits the picture of capsular distention, with increase in synovial fluid. It differs little from the first stage of an infectious process in which a swelling of the soft tissues exists. However, if continued over a long time, destructive and productive changes occur in the joint. Traumatic joints are usually seen as occupational injuries (for instance, in riveters), they result in postural deformity due to repeated injury to the joint surface, and they are seen in injuries of bone in which trauma causes proliferation.

The injury may be of any one of several types

- (1) A single severe injury to the joint cartilage,
- (2) Repeated mild trauma to the joint cartilage,
- (3) Disorganization of the mechanics of a joint,
- (4) Faulty weight-bearing on account of bony deformity so that use brings about repeated injury to the joint surface,
- (5) Gradual deformity of a joint by abnormal pressure.

II The Infectious Type—This type includes tuberculosis, gonorrhea, syphilis,

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present The cartilage in this stage has become involved and may be more or less destroyed, according to the severity of the infection, evidenced by the fact that the joint space is narrowed The infection may have localized sufficiently at one part of the joint to destroy all the cartilage and actually involve the bone beneath, in this event any bone change can be easily seen upon the plate While the soft tissues around the joint are still swollen, there may be atrophy of the soft tissues above and below the joint, particularly true in long-standing infections, such as tuberculosis This second stage is variable as to length of time, and the same changes persist as long as the infection is active The atrophy, however, becomes greater the longer the acute stage exists There is no production of new bone, as this is a repair process and cannot take place during the height of the disease

With the subsiding of the infection, the third stage, or the stage of repair, is ushered in Here too, the picture is slightly different, depending upon whether the examination is made at the beginning or at the end of this stage The swelling and fluid have disappeared, the atrophy is still present, and will disappear only when the joint begins to function again The destructive process, however, has ceased and repair now takes place Unfortunately the cartilaginous surfaces which are so easily attacked have little recuperative power in themselves Cartilage reproduces itself to only a limited extent, and so Nature has to fall back upon two substitutes the destroyed area is either filled in with fibrous tissue or the raw, exposed bone proliferates, filling up the destroyed area This overgrowth is spoken of as exostosis and its extent is dependent entirely upon the extent and severity of the infection Where two opposing articulating surfaces are denuded of cartilage, the resulting new bone formation from both surfaces may unite and produce actual bony ankylosis It is interesting to note that the infection or its toxins shows a marked predilection for the ligamentous

attachments, and the first bone proliferation is found in these points

III Atrophic Arthritis—In a study of 62 cases conducted by us, we found the atrophic type of arthritis, with its cartilaginous destruction and ankylosis, predominant in tall, poorly developed, slender, viscerotropic individuals, and in females In the latter, pain, disability, and deformity seem to be the chief complaints

The atrophic lesions are generally seen from birth to middle life The x-ray examination shows marked atrophy of both soft tissues and bone, and the joints are frequently partially ankylosed due not to bone but to fibrous changes and muscle contracture There is extensive absorption of cartilage, even to the point of its complete destruction in certain areas, but apparently Nature makes no attempt at new bone formation There is a thinning or destruction of the joint cartilage, with atrophy of all soft tissues and bone from disuse Though there is no new bone formation as a rule, frequent subluxation of the joint due to tendon contraction is seen with lack of motion due to fibrosis and contracture The earliest pathologic change is proliferation of the synovial membrane, which is not definite in roentgenograms, but, the marked osteoporosis and decrease in density of the bone ends give the appearance of atrophy in the x-ray plate

In the atrophic type of arthritis, we note an early proliferation of the synovial membrane, with erosion of the articular cartilage and pannus formation Finally, destruction in the articular cartilage takes place, with fibrous or bony ankylosis It is in this type of arthritis that motion is essential in the treatment of the joints When the joint has recovered as far as possible there is absence of swelling and fluid, atrophy has disappeared, followed by the marked formation of exostosis or actual bony ankylosis, depending entirely upon the severity of the lesion

IV Hypertrophic Type—This is a disease almost invariably associated with individuals of middle and old age, since



Fig 1 Traumatic arthritis Dorsal ventral view of foot showing union at metatarsal phalangeal joint of big toe due to trauma (see arrow) Patient kicked a large stone by mistake resulting in bony union after which followed traumatic arthritis

pneumococcic infections, etc., and those types of arthritis which have the same clinical manifestations, though the exact etiologic factor is unknown. This group does not seem to be limited to any age period, and is as prevalent in the second as in the third age period. It is true that certain acute infections, such as gonorrhea or tuberculosis, are more common in the second age period.

The first change to take place is swelling of the synovial membrane. In the ma-

jority of affected joints, the flesh and skin outline will indicate this by the enlargement of the soft tissues. With this inflammatory change of the synovial membrane, fluid will form, in most joints one can infer this by the position of the part and the swelling around the joint. In the case of the knee, the riding patella will be seen. If this infection is severe, the next point of attack will be the cartilage. Here also the structure is not demonstrable by the x-ray and again the condition must be determined by indirect evidence, that is, the width of the joint space. If the cartilage is uniformly eroded, the joint space will be narrowed. The infection may go on to complete destruction in certain areas and attack the bone beneath. Immediately the bone becomes involved there is direct evidence of destruction that can be demonstrated upon an x-ray plate.

From an x-ray standpoint, infectious arthritis presents three different appearances, according to the stage of the disease at the time of the examination. In the first stage, at the onset of the infection, the plate shows distinct swelling of the soft tissues around the joint, with increase of synovial fluid. That there is no cartilaginous destruction is evidenced by the fact that the joint spaces are of normal width. Since the cartilage has not been involved, of necessity there can be no bone change. There is no atrophy, as sufficient time has not elapsed to bring about this condition. This stage gives the same x-ray appearance as an acute polyarticular rheumatism or an injury to the joint without fracture, because in those conditions fluid and periarticular swellings are also present, and no cartilaginous changes appear.

In the second stage the disease probably reaches its maximum intensity and in time changes take place in the joint and bone. When sufficient time has elapsed for the joint to become more or less immobilized, either from pain or treatment, consequent atrophy of the bones forming the joint appears. The swelling and fluid are still

lesions were in the lumbar region, and became progressively fewer as one ascended the vertebral column. Therefore, in the case of a heavy, well-developed individual, it seems that those segments which are under the greatest mechanical stress undergo the greatest amount of strain and lipping.

As Pemberton concisely says, the peripheral circulation becomes greatly slowed up in hypertrophic arthritis, with the resultant formation of fibro- and chondro-osseous spicules deposited in various sites. We noted a strong tendency for the ligamentous structures about a joint to become ossified, with marked diminution of function in the joint. In time, these structures become more and more susceptible to injury and recover more slowly in the event of subsequent trauma.

Chronic Osteo-arthritis—The earliest change consists of the formation of osteophytes at the articular margins. These osteophytes are smooth in outline, usually fairly regular and rounded in shape, and may attain considerable size. When large, they frequently become detached as a result of minor injury, and may in some cases form intra-articular loosebodies. Concurrently with the osteophytic formation, gradual erosion of the articular cartilages takes place, evidenced in the roentgenogram by a narrowing of the joint space. In time, the underlying cortex is eroded, but this destruction is counterbalanced by subcortical sclerosis, producing the dense, eburnated surfaces so characteristic of advanced osteo-arthritis.

Bony ankylosis practically never takes place, because of this.

In hypertrophic arthritis there is increased density of the bone. Therefore, in this condition, a lime salt deposit occurs in the form of chondro-osseous spicules at the articular margins, which become definite in a roentgenogram. No atrophy of either bone or muscle controlling the joint occurs until very late in this condition.

Briefly, to summarize the difference between these different conditions the following points are to be borne in mind. Atrophic arthritis is seen largely in the second age period, hypertrophic arthritis in the third age period, while infectious arthritis occurs in any age period.

Arthritic Changes Due to Age—Great care must be taken not to confuse the slight changes which are always present in old persons with acute active processes. It has been definitely established that practically all of us, when we reach the age of 45, show a small exostosis in and around the joints, particularly where the ligaments attach, and yet there may be no clinical manifestations of an arthritic process. This naturally means that there is a quiescent arthritis present, which needs only the proper stimulation to become an active process. It is in just such cases that marked symptoms follow a slight injury, symptoms out of proportion to the extent of the injury. In this condition we must remember that the injury has simply lowered the resistance of the joint and has allowed this quiescent arth-

TABLE I—SIXTY-TWO CASES STUDIED FROM 1928-1930

	No	Status	Location	Age	Sex
Traumatic arthritis	5	Stocky persons, well developed	85% knee 10% ankle 5% scattered	Any age	
Infectious arthritis	8		55% shoulder joint 35% elbow joint 10% scattered	Any age.	
Atrophic arthritis	11	Plotic slender, tall poorly nourished	60% ankle 20% knee 20% other parts	From 2 to 38 years	85% Female 15% Male
Hypertrophic arthritis	38	Well developed heavy, sluggish	20% knee 70% lumbar spines 10% scattered	From 40 to 75 years	58% Female 42% Male



Fig 2 Infectious arthritis Case 1 Patient aged 54 with streptococci infection. Roentgenogram shows condition of right ankle joint on Feb 10 1931 two days after onset of infection

Fig 3 Shows the right ankle joint on Feb 16 1931. Note the progressive intra articular destruction

Fig 4 Shows the same ankle joint on Feb 23 1931. Note the areas of destruction and absorption of cartilage and bone with narrowing of intra articular space

one rarely sees it in those under forty, and it is most pronounced in patients in the neighborhood of fifty and over—the third age period. Attention has already been drawn to the fact that as we grow older there is a generalized atrophy of all the bones, which we look upon as normal change due to old age. Consequently, since this disease is one of old age, one would naturally expect to find atrophy in hypertrophic arthritis, on the contrary, however, the x-ray examination shows no atrophy and apparently an increased deposition of calcium, so that the bone shadows are even a little more dense than normal.

There is no swelling or fluid in the joint. The cartilage is destroyed in focal spots in these areas, bony exostoses appear, and there is marked new bone formation

at the attachments of the ligaments of the joints. Frequently small bony bodies lie free in the joint cavity, and these “joint mice” may become engaged in the joint, resulting in swelling and fluid, but this is an accidental factor and not one to be met with in the normal course of the disease. There may be ankylosis of the joint—not a true ankylosis due to fibrous tissue or bone union, but simply a mechanical locking of opposite engaging exostoses. This type simulates the third stage, or the stage of repair, in an infectious arthritis. The two conditions, however, would only be confused in old persons, since the Hypertrophic Type does not exist in the second age period.

In the cases of the hypertrophic form studied, we found that the majority of

ANIMAL EXPERIMENTS WITH COLLOIDAL THORIUM A STUDY IN LYMPHATIC ABSORPTION¹

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THE introduction of colloidal thorium into commercial use under the name of "thorotrast" aroused many hopes in the field of radiologic diagnosis of diseases of the liver and spleen. I became interested in the subject in the early months of 1932, and decided to study the value of colloidal thorium in radiologic visualization of lymphatics of the abdominal cavity. This necessarily led to a comparison of findings in the intravenous and intraperitoneal use of the colloidal metal, and further comparison of these findings with those obtained by a simultaneous intraperitoneal injection of colloidal thorium with other substances, namely, pure silica, as SiO_2 , known as a colloidal poison.

EXPERIMENT 1 (R1)

Twelve c.c. of thorotrast, diluted in ten c.c. of sterile saline, was injected intravenously into a rabbit that weighed four pounds. Exposures were made from then on, at first daily and then weekly, until the time of autopsy which was performed 60 days after the injection. As long as the rabbit lived, no ill effects could be noted, judging from the behavior of the animal.

X-ray Findings—Twenty-four hours after the injection, the liver and spleen were visualized, casting a dense shadow when compared with the film taken before the injection. The spleen showed a granular structure and was much more dense than the liver. The shape and size of the spleen changed with each exposure, according to its position and contractility (Fig 1). An intra-abdominal injection of thorotrast was also attempted on the same rabbit. The thorium was deposited in the muscular wall and after a few weeks

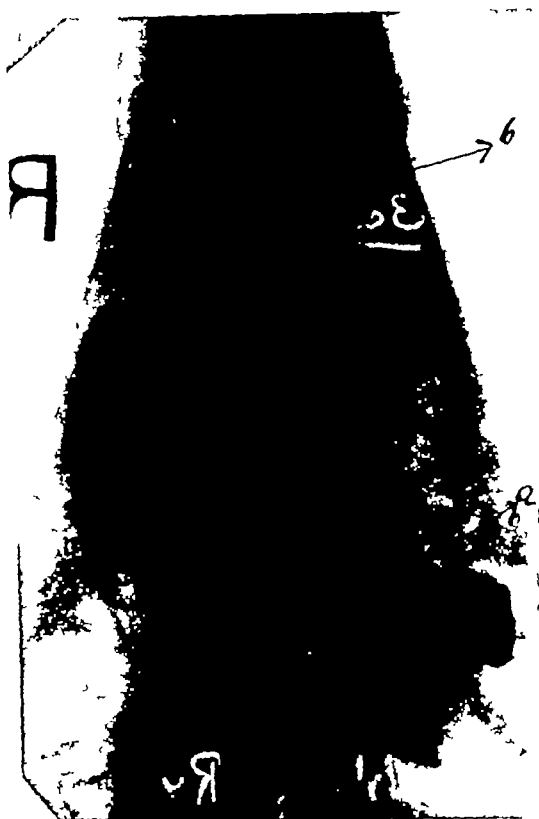


Fig 1 Experiment I 24 hours after intravenous injection (a) spleen, (b) liver

could be seen spreading in both directions. Some of the regional inguinal glands were visualized. At the autopsy, the following organs and parts were removed and x-rayed immediately after removal: liver, spleen, kidneys, testicle, adrenal glands, heart and lungs, a piece of rib, and the left femur. There was evidence of the dye on the films in the spleen, liver, lungs, and bone marrow.

Microscopic Findings—A small amount of thorium was found in the lung, bone marrow, and adrenal gland, the largest amount being in the lung. None was seen in the kidneys and testicle. The spleen (Fig 2) was packed with thorotrast in the

¹ Read before the American Congress of Radiology, at Chicago Sept 25-30 1933

ritis to flare up into an active process, really the result of the arthritis and not of the trauma

Since arthritis is a systemic disease, it has prodromes that the joint manifestations are only local expressions of the systemic disturbances and that the processes may manifest themselves elsewhere

The atrophic type of arthritis can be produced experimentally, by injecting the joints of rabbits with streptococci. On the other hand, the hypertrophic type cannot be produced experimentally with bacteria, but it can be produced by introducing a foreign body into a rabbit's joint. This seems to prove that atrophic arthritis is bound up some way with trauma or the

wearing out of a joint, i.e., it is a degenerative process. The importance of this point of view from the standpoint of treatment is great. It means that in atrophic arthritis, one's efforts should be directed first to the removal of all foci of infection, after which one should proceed to build up the patient in a constitutional way, whereas, in the hypertrophic type, one need not perhaps be so eager to remove the foci, but first to direct attention to resting the joint, relieving strain and giving support.

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particularly dense and has a granular appearance

Fifty-two and 74 hours after injection, the films show further progress in the absorption of the thorium from the peritoneal cavity, as above described

Twenty-two days after injection, plates show a distinct diminution of the amount of thorium in the abdominal mesenterial lymphatics. The last ones are sharply defined, the peritoneal lining is sharply outlined. This process of re-absorption of thorium from the peritoneal cavity goes on further, as one can see on the follow-up plates taken 48 days and finally 155 days after the injection, giving a very sharp outline of the peritoneal lining with all of its pouches (for pancreas and rectum), and of the mesenterial lymphatics. The lymphatic cisternæ in the chest are now smaller but of greater density. Most of the thorium that was lost in the muscles of the abdominal wall spread downward. Some of the lymph glands in the right axillar region were visualized

The animal having been embalmed, an autopsy was performed five months after the injection. The site of injection was examined first. The thorium could be seen extending below the skin, through the muscles on the right side of the abdominal fascia, and downward toward the right inguinal region. At the point of the injection, a hard nodule of thorium could be palpated. Glands in the right axilla and alongside the right chest wall could also be palpated. On opening the peritoneal cavity, the thorium could be seen distributed over the entire peritoneal lining, forming a fine network, and consisting of small thorium granules. Also, several small cysts, surrounding clumps of thorotrast, could be noticed. On transillumination, the mesenterial lymphatics could be clearly seen as very fine white to gray lines. The arteries and veins stood out distinctly in the mesentery, filled with the gray colored lymphatics. The following organs were examined: glands, from chest and axilla, sternum, with the mammary vessels, and lymphatics, diaphragms, ab-

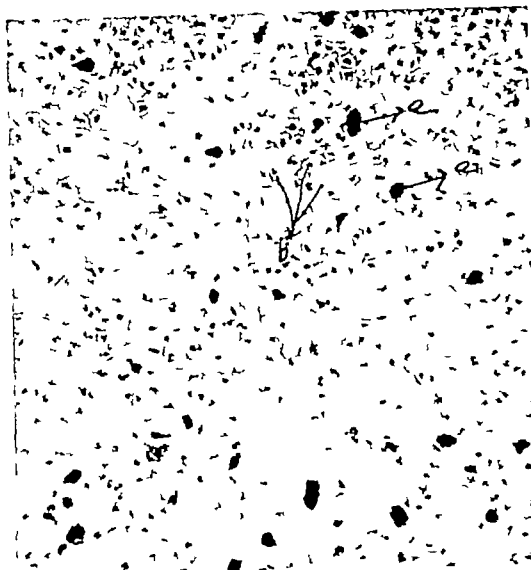


Fig 3 Experiment I liver, 60 days after intravenous injection (a) thorium granules in the reticulo endothelial cells, (b) pycnotic dense degenerated nuclei of the liver cells

dominal wall, mesentery with cysts, adrenals, kidneys, thymus and ovaries, and lungs

Microscopic Findings—The bulk of the thorium was seen in the lymphatics of the peritoneal lining and mesentery. These lymphatics were situated mostly around the vessels. The thorium granules appeared like drops in the flattened cells, the nuclei of which could hardly be discerned. The thorium was also seen in the capsule and cover of the spleen, diaphragms, liver, and of all the other intra-abdominal organs. Next in amount, the thorium was present in the spleen, the distribution of which is similar to the one above described in R1 (Experiment I). There is, however, a smaller amount of thorium present than in R1. A comparatively small amount of thorium was seen in the liver, distributed in the same way as in R1. There is no evidence of degenerative changes of the liver cells in this case. The thorium was further found in the anterior chest wall (anterior mammary lymphatics), in the lymphatic sacs of upper chest, also in the capsule of the adrenals, in the abdominal wall, and

form of clustered granules, situated in the perilymphatic spaces and in the pulp. Occasional thorium patches could be noted

EXPERIMENT 2 (R2)

Under fluoroscopic guide, 20 c c of undiluted thorotrast was injected intraperitoneally into a rabbit that weighed about four pounds. Five c c of the substance was lost in the skin and muscles of the abdominal wall. Immediately after the injection, a fluoroscopic examination showed a rapid distribution of the thorium throughout the peritoneal cavity. Plates were taken at short intervals of from 3 to 100 minutes after the injection, following which more serial plates were taken from 24 hours up to five months.

X-ray Findings—For comparison, a plate of the abdomen was taken before the injection. Three minutes after the injection, the film shows rapid distribution of the thorium throughout the entire peritoneal cavity, some of it can be seen penetrating through the mesenterial and omental lymphatics into the upper surface of the diaphragm. This process of upward absorption can be seen progressing on the film, taken 15 minutes after injection. Films taken 50 and 100 minutes after injection (lateral views) show the thorium outlining the pleural surfaces of the diaphragm, also a suggestion of linear lymphatic vessels behind the sternum, and an accumulation of thorium in the upper anterior chest just behind the manubrium sterni, of about 2×3 mm in size.

Twenty-five hours after injection, plates were taken in the postero-anterior and lateral positions. In the chest, the lymphatic vessels behind the sternum are much better visualized, showing increased density. The same applies to the areas of accumulation of thorium in the upper chest, which are apparently situated around the jugular veins and represent large lymphatic sacs or cisternæ. The abdominal cavity shows a better definition of the mesenterial lymphatics, also an outline of the peritoneal lining. All the lymphatic sacs in the abdomen show large clumps of thorium, particularly those below the liver. The liver and the spleen are of increased density. The spleen is

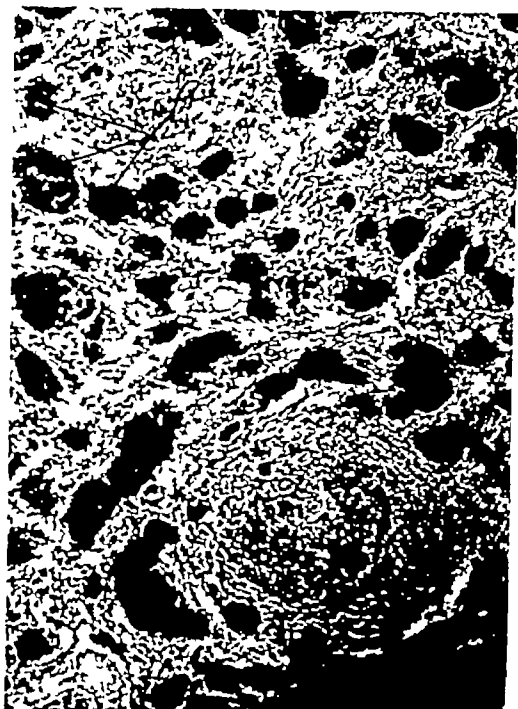


Fig 2 Experiment I spleen 60 days after intravenous injection (a) large clumps of thorium filling the reticulo-endothelial cells to capacity. Some of them are arranged around the lymphatic centers.

in the center of a lymphatic follicle. No definite degenerative changes due to radioactivity could be found in the lymphatic centers of the spleen. The liver (Fig 3) contained the bulk of the thorium particles. It was taken up by the reticulo-endothelial cells in the form of fine granules. The parts of the liver lobules which contained the bulk of thorium particles, as above described, show definite advanced degenerative changes, the liver cells lost their color, their nuclei are dense, pycnotic, and their protoplasm is retracted. The periportal fields show only occasional thorium-containing cells. The liver cells around the periportal fields preserved their normal color and appearance.

axillary lymph nodes No thorium was seen in the ovary or thymus or kidneys Due to embalming, the pulmonary alveoli were filled with fluid which made the sections not useful for diagnosis

EXPERIMENT 3 (R3)

Ten c c of thorotrast and one gram of pure silica² dust dissolved in ten c c of water was injected intraperitoneally in a rabbit, weighing about three and a half pounds No ill effects could be noted from the injection during the lifetime of the animal Plates were taken before and 15 minutes after injection This was followed up by plates taken 24 hours, six weeks, and three months after the injection, the last ones taken just before the autopsy

X-ray Findings—Plates taken 15 minutes after the injection show a diffuse spreading of the metal throughout the peritoneal cavity with upward absorption, pointing to the diaphragms The absorption from the peritoneal cavity is much faster than in R2 (Experiment II) This could be seen on the film taken 24 hours after injection The anterior mammary lymphatics appear very thick and dense on these films, indicating a much faster rate of absorption Films taken six weeks and three months after injection (Fig 5) show a much smaller amount of thorium in the peritoneal cavity than in R2 The peritoneal lining and the mesenteric lymphatics are visualized, but not as well as in R2 A large amount of thorium was present in the lymphatics of the large omentum The spleen, however, is well visualized, the liver is of increased density

Autopsy Findings—The autopsy was performed a little over three months after the peritoneal injection The peritoneal cavity shows much less thorotrast, both in the peritoneal lining and in the mesentery, than in R2 A great deal of thorium was accumulated in the large omentum In certain places, the thorium could be found

² The dust was the same as that used in the guinea pig experiments It contained 99.5 per cent pure silica as SiO₂

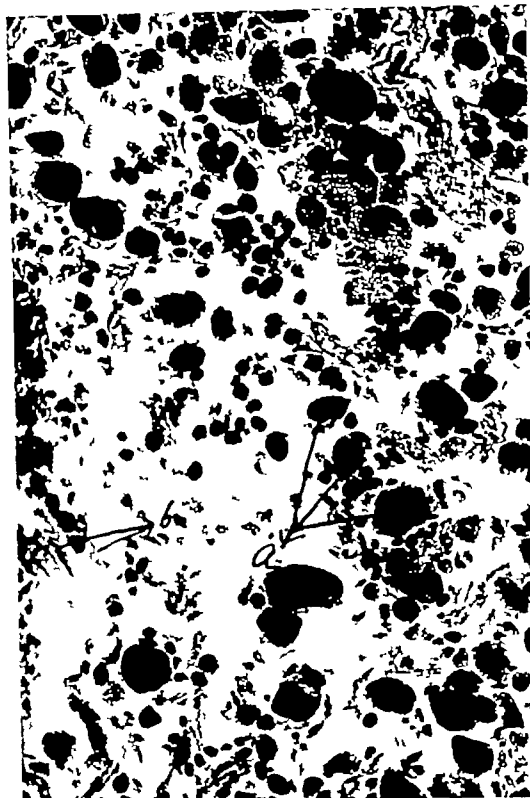


Fig 5 Experiment II, mesenteric lymphatics
(a) thorium granules in the reticulo-endothelial cells
(b) loose fibrous tissue

forming small lumps in the peritoneum Lungs showed no consolidations that were palpable, they were of pinkish gray color and in places showed white spots under the pleura The following specimens were removed abdominal wall including the peritoneal lining, liver, spleen, testicle, large omentum with nodules of thorium and pancreas, kidneys, adrenal glands, diaphragms, sternum, trachea, lungs and heart, lump of thorotrast from the chest, femoral artery and tibia, and bone marrow

Microscopic Findings—The largest amount of thorium could be found in the spleen, liver (Fig 6), bone marrow, and abdominal lymph nodes There was less thorium in the mesenteric lymphatics than in R2 There was also less in the lymphatics of the diaphragms No thorotrast could be seen in the kidneys, adrenals, testicle, and pituitary The liver showed a larger amount of thorium than in R2

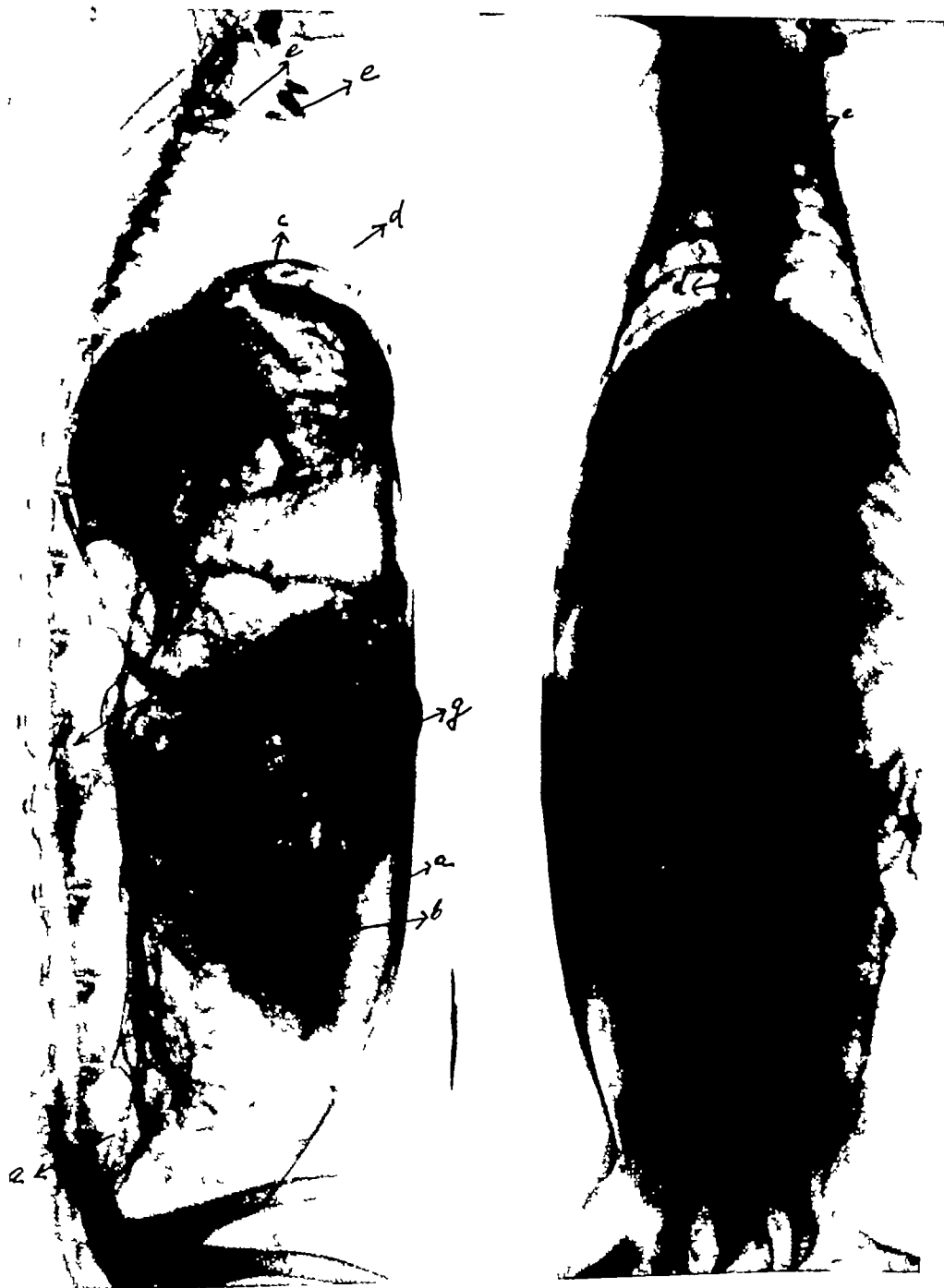


Fig 4 Experiment II 155 days after intraperitoneal injection (postero-anterior and lateral views) (a) peritoneal lining and peritoneal lymphatics, (b) mesenteric lymphatics (c) diaphragmatic lymphatics (d) anterior mammary lymphatics (e) large lymphatic sacs in the mediastinum (f) spleen (g) thorium in the abdominal wall

tice that the retention of thorium in the liver and spleen varies in different animals. This was also observed by Leipert. It is difficult to explain just how this takes place, unless one assumes that the absorption of thorium in the cells is not a stable process. Possibly, the thorium particles are again thrown into the blood stream and reabsorbed. The thorium is eliminated through the lungs and the gall, none, or very little, through the kidneys. The process of elimination of thorium is a very slow one. It takes months, probably years, and it may last through the life time of the individual or animal. In our experiments (R1 and R3), the liver cells show definite signs of degeneration. It is true, considering the weight of the animal, that an overdose was used, about six times as much as was necessary for hepato-lienography.

I consider also of some significance the peculiar distribution of thorium in the liver lobules. As pointed out before, the thorium is situated near the central veins and away from the periportal fields. This speaks also for possible repeated reabsorption of the metal from the blood stream.

By means of an intraperitoneal injection of thorium, we are able to visualize the peritoneal lining and the mesenteric lymphatics in normal cases, as one can readily see in the second experiment. It also demonstrates the rate of absorption of thorium through the diaphragmatic and anterior mammary lymphatics into the blood stream. From there, the thorium was again taken up by the liver, spleen, and bone marrow. Since the bulk of thorium was retained in the mesenteric lymphatics, a smaller amount reached the liver and spleen, causing no damage and showing no signs of degeneration to the liver cells. This I think, is important in consideration of toxicity between the intravenous and intraperitoneal injections. One can foresee the possibility of visualization of pathologic processes of peritoneal lining or intra-abdominal pathology (pancreas and retro peritoneal tumors metastatic tumors) by means of intraperitoneal

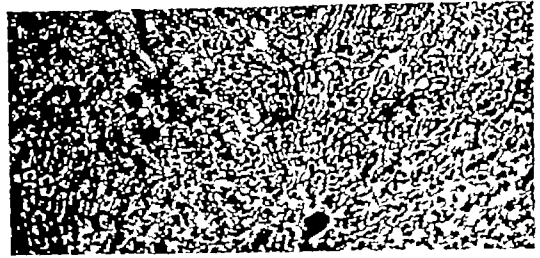


Fig 7 Experiment III liver, 3 months after intraperitoneal injection of thorotrast and silica combined (a) pycnotic nuclei of liver cells indicating degenerative changes, (b) thorium granules

injections of small amounts of the colloidal thorium. The immediate absorption of the thorium by means of lymphatics may also be of value in the study of the tumor lymphatics in different kinds of malignancy.

The third experiment of simultaneous intraperitoneal injection of colloidal thorium and silica was performed for the purpose of studying the difference in lymphatic absorption of the two different colloidal substances. First, it could be noticed that the rate of absorption of the thorium from the peritoneal cavity was much faster when injected together with silica. Otherwise, the findings were analogous to the second experiment except for the retention of larger amounts of thorium in the spleen and liver, as in the R3, with degenerative changes in the liver cells. This brings us to a conclusion of a possibility of combining thorium with other harmless chemicals in order to speed up the rate of absorption of the metal. As a secondary result of the third experiment (R3), one can consider the production of interstitial focal pneumonitis in the lungs of the rabbit due to the retained silica particles absorbed from the peritoneal cavity (Fig 7). This type of early interstitial pneumonia produced about three months after injection is analogous to the intravenous injection of pure silica in rats and guinea pigs reported by Martland and myself, in 1932. This experiment of combined injections also showed us the difference in the chemical affinity of the two col-

The liver cells again showed signs of degeneration which were not as pronounced as in R1. A small amount of thorotrast

COMMENT

One can readily see that the thorium injected intravenously is taken up by the



Fig 6. Experiment III. 3 months after intraperitoneal injection of thorotrast and pure silica combined. (a) peritoneal and mesenteric lymphatics (compare with Figure 4 and note the small amount of thorium in the abdominal cavity) the rest is the same as in Figure 4.

was injected around the left femoral arteries. The specimen showed an absorption of thorium in the periarterial lymphatics

reticulo-endothelial cells in the liver, spleen, and bone marrow. This gives us the opportunity of visualization of these organs by means of X-rays. One can no-

tice that the retention of thorium in the liver and spleen varies in different animals. This was also observed by Leipert. It is difficult to explain just how this takes place, unless one assumes that the absorption of thorium in the cells is not a stable process. Possibly, the thorium particles are again thrown into the blood stream and reabsorbed. The thorium is eliminated through the lungs and the gall, none, or very little, through the kidneys. The process of elimination of thorium is a very slow one. It takes months, probably years, and it may last through the life time of the individual or animal. In our experiments (R1 and R3), the liver cells show definite signs of degeneration. It is true, considering the weight of the animal, that an overdose was used, about six times as much as was necessary for hepato-lienography.

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Fig. 7 Experiment III liver, 3 months after intraperitoneal injection of thorotrast and silica combined. (a) pycnotic nuclei of liver cells indicating degenerative changes. (b) thorium granules.

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Fig 8 Experiment III lungs (a) interstitial pneumonic type of infiltration around the large bronchus as in early silicosis, (b) normal alveoli

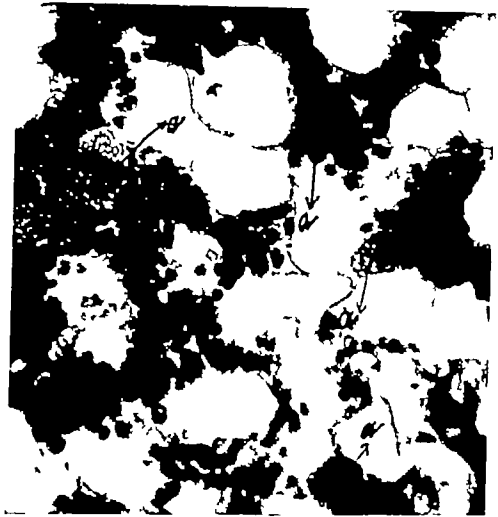


Fig 9 Experiment III bone marrow (a) thorium granules in the reticulo-endothelial cells of the bone marrow after intraperitoneal injection of thorotrast and silica combined

loidal substances, silica to the lungs, and thorium to the reticulo-endothelial system

Notes on Radio-activity—While our experiments were not directed toward establishing the damages of the tissues due to radio-activity, one must consider seriously the degenerative changes in the liver, in the R1 and R3. They are unquestionably the result of toxicity of the thorium partly due to an overdose, with a possible accentuation of the radio-activity by the x-ray exposures

The radio-activity of the metal can be easily demonstrated by a simple photographic test. A piece of metal interposed between a dental film and a 12 c c bottle of thorotrast gave a clear image of the metal after seven days of exposure.³ Martland showed us, in his extensive work on radioactive substances and on his human material of luminous dial workers, the importance of the fact that nothing should be done to increase the radio-activity of the

³ The paper covering the film was interposed between the bottle containing thorium and the film

human body. He also showed us that it will take from seven to twelve years before the latent radio-activity of thorium can be established. Until then, great care in the intravenous use of thorium is advisable.

CONCLUSIONS

1 A comparison of intravenous and intraperitoneal use of colloidal thorium was made and studied by means of serial x-ray examinations and microscopic findings

2 In the case of intravenous injection, degenerative changes in the liver were found as a result of radio-activity

3 The normal peritoneum, mesenteric lymphatics, and the anterior mammary lymphatics were visualized by means of an intraperitoneal injection of thorium. The rate of its absorption into the blood stream was studied. The importance of the intraperitoneal injection for recognition of abdominal pathology was stressed

4 A combined intraperitoneal injection of thorium and silica was made. Its rate of absorption through the lymphatics was studied radiologically and microscopically

5 As a secondary result of this combined intraperitoneal injection of thorium and

silica, a first-stage interstitial productive focal bronchopneumonia, due to silica, was produced in a rabbit three months after injection

In conclusion, I wish to thank Dr H S Martland for his kind help, which made it possible for me to prepare this paper I also wish to express my appreciation to the Heyden Chemical Company for their help and co-operation, as well as to Mr E S Rubinow, college student, for his able assistance

31 Lincoln Park

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A GAS X-RAY TUBE FOR IRRADIATION WITH SOFT X-RAYS¹

By H. KERSTEN, *Department of Physics, University of Cincinnati*

X-RAYS of longer wave length than 1 \AA unit, which have been more or less arbitrarily called soft, are of interest in biological experiments. A gas x-ray tube, with a fairly large window, for producing x-rays ranging from about 0.5 to about 4 \AA units and for continuous operation at such combinations of voltage (up to 50 peak K V) and current (up to 50 ma) that their product is about 700 volt-amperes, is described below.

A photograph of the tube placed so that the x-rays will travel downward is shown in Figure 1. Two kinds of windows, both made of 0.045 mm cellophane, covering openings three-quarters of an inch in diameter, are provided. Cellophane of this thickness is strong enough to withstand the air pressure and is sufficiently vacuum tight, but is damaged by heat and flying particles. The first type of window is intended to protect the cellophane by placing it about 12 cm from the focal spot at the end of a nozzle, as shown in Figure 1 and at 7 in Figure 2. Such a window will transmit a large percentage of the L radiation of silver (about 4 \AA) and will last about half an hour when the tube is operated at 50 ma and 15 peak K V, or about two hours at 50 ma and 8 peak K V.

The second type of window, shown at the bottom of Figure 3, protects the cellophane from heat and flying particles by means of an aluminum disc placed between it and the target, and far enough away from the cellophane so that the two will not touch when the cellophane is pushed in by the air pressure. With this combination, it is possible to use a disc of aluminum which would be too thin to withstand the air pressure against the three-quarter inch opening. Such a window, with a disc of 0.045 mm aluminum, will transmit a large percentage of the K radiation of copper (about 1.5 \AA), and will last about

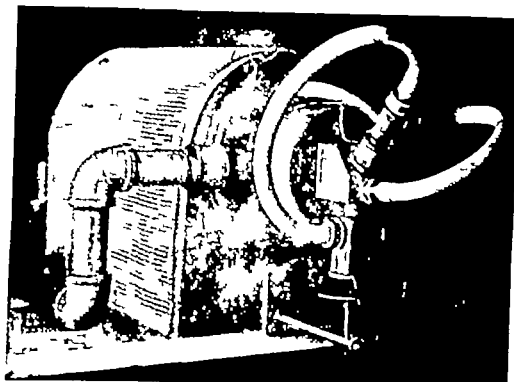


Fig. 1

ten hours when the tube is operated at 10 ma and 40 peak K V.

The cellophane is sealed to the nozzle, or head of the x-ray tube as the case may be, by first warming the surface to which it is to be sealed, with a Bunsen flame. After the surface is warm enough, it is "tinned" with a rather heavy layer of Picein² sealing wax by rubbing a warmed stick of the wax against the warmed surface. The cellophane is then pressed against this warm layer of sealing wax, and a warmed mould, having small circular concentric corrugations in its surface, pressed against the cellophane. The mould presses corrugations in the cellophane and sealing wax, concentric with the window. The cooling water keeps the sealing wax hard during the operation of the tube so that the corrugations prevent the cellophane from slipping. There are no corrugations in the surface to which the sealing wax is applied. This method of sealing on the window makes it possible to place the material to be irradiated near the window so as to permit very little loss, due to the absorption of the soft radiation by the air.

The grounded end of the tube is cooled

² Picein is distributed by Schrader and Ehlers, 239 Fourth Ave., New York.

by tap water which enters through the hose coupling 1 (Fig 2), passes through the tube 21 to the target 23, out of the coupling 2, through 5 and 31, and into the head of the tube through coupling 4. From this point it passes through two vertical holes

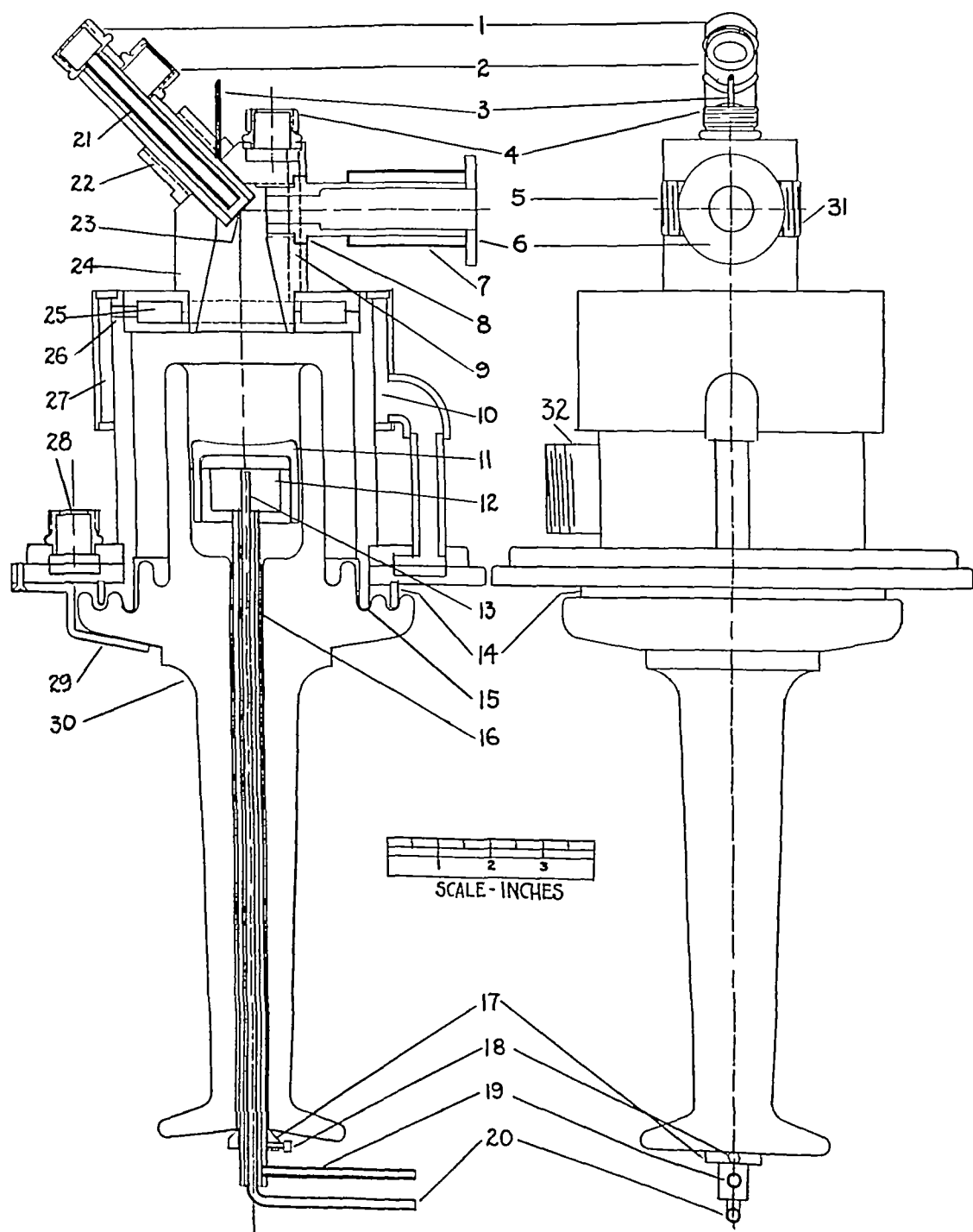


Fig 2

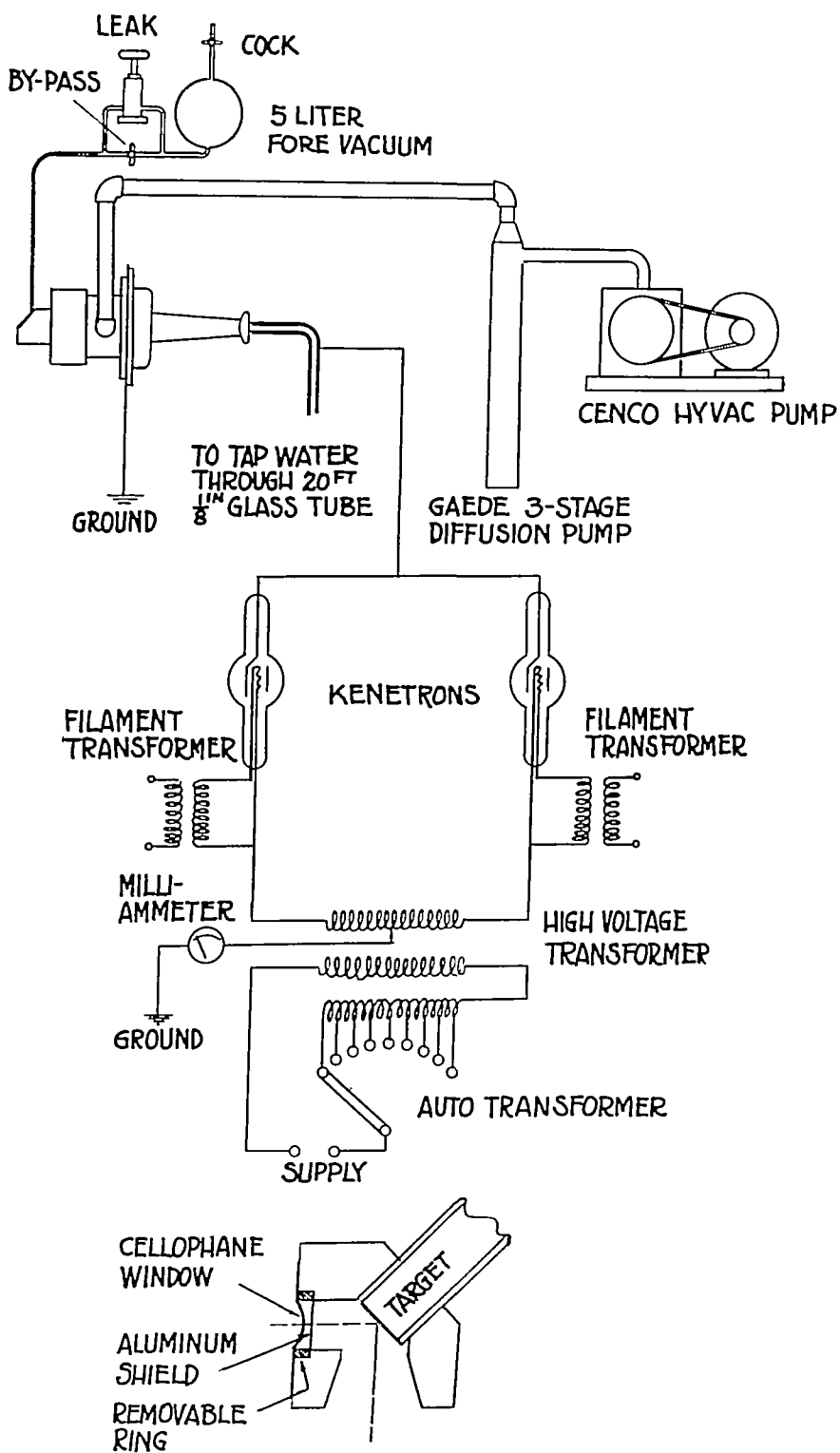


Fig 3

9, in the head, into the annular space 25, through the hole 26, into the jacket 27, and out through the tube 10, into the annular ring to which the insulator is attached, then out through the coupling 28. The water for part of this circuit passes through rubber hoses. The ungrounded end of the tube is cooled by tap water which passes through 20 feet of $\frac{1}{8}$ -inch glass tube, then through 20 and 13, into the space 12, and out through tubes 16 and 19, through another 20 feet of $\frac{1}{8}$ -inch glass tube to the drain. A small amount of current leaks away through the water to the ground.

The insulator³ 30, is sealed at 14, with Picein sealing wax. The best method for sealing it to the metal part of the tube is to heat the latter by passing steam through the water jacket, "tin" the surfaces with sealing wax to be in contact with the insulator, and place it in a vertical position with the window end downward. Meanwhile, the insulator may be heated in an oven, the parts to be in contact with the metal "tinned" with sealing wax, and melted sealing wax poured into the outer groove of the insulator. Finally, the insulator should be pressed against the metal part of the tube, and the whole cooled by passing tap water through the water jacket. The ring and groove at 15 prevent the sealing wax from getting inside the tube. Sealing wax should also be placed around the tubes at 17. When the tube is mounted in the position shown in Figure 1, the cleat 29 takes some of the weight off the sealing wax joint.

The cathode is made of aluminum with a concave surface having a radius of curvature of about 10 centimeters. It is pressed

on the copper shell 12, which provides a large amount of surface to conduct away the heat. The size of the focal spot may be changed by loosening the screw 18, and changing the position of the ring 17, to permit the cathode to move nearer to, or farther from, the target. A broad focal spot does not cause as much damage to the window as a fine one. The target and the hole at 22 are threaded to permit alignment of the focal spot with the window. The window hole is also threaded for receiving the nozzle. Both these joints are made vacuum tight with Picein.

The vacuum circuit is shown at the top of Figure 3. The tube, which is pumped out through the connection 32 (Fig. 2), is joined by means of a right-and-left-hand pipe coupling, with a one and one-quarter inch galvanized iron water pipe, the connections of which are soldered, except at the coupling and at the mercury pump. These are sealed with Picein. Since this arrangement does not permit a satisfactory liquid air trap to be inserted, some of the mercury vapor gets into the tube, amalgamates with some of the targets, and, if the voltage is high enough, gives off the L lines of mercury. For most irradiation, the extra lines do not matter. Air is permitted to leak into the tube, through the small copper tube 3 (Fig. 2), from an adjustable leak such as those which have been previously described.^{4 5 6}

The electrical circuit⁷ shown in the middle of Figure 3, makes use of two type KR-3 kenotrons, connected so as to give full-wave rectified, pulsating current.

⁴ Kersten *Rev. Sci. Inst.* July 1931 2, 377.

⁵ Kersten and Lange *Rev. Sci. Inst.* June 1933, 4, 332.

⁶ Kersten *Rev. Sci. Inst.* January 1934 5, 5.

⁷ The high voltage apparatus was made by the Kell-Lev Koett Co. Covington Ky.

³ The insulator is sold by Dr. Carl Leiss, Berlin-Steglitz, Eldstrasse 10, Germany.

THE EXPONENTIAL LAW OF TISSUE RECOVERY APPLIED TO RADIUM AND RADON DOSAGE¹

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It has often been assumed that tissue recovery from radiation effects follows an exponential law. By the use of this law in the saturation technic of radiation therapy, tissue recovery is calculated for the time between treatments. When a treatment lasts for only a short time, the tissue recovery during the period of treatment is negligible, but when a treatment lasts for many hours, as many radium and radon treatments do, the tissue recovery during this period may not be negligible. In some instances, it seems possible that a better correlation between tissue effect and the dose given might be obtained if the saturation dose, which takes into account the tissue recovery during the treatment, was considered rather than the total dose.

The expression "tissue recovery from radiation effects" is indefinite because little is known about the effects of radiation on tissue. Most of the effects usually considered to be due to irradiation are probably secondary effects caused by a primary effect. The primary effect is caused by an absorption of radiation, or, since radiation is energy, by an absorption of energy, the magnitude of this primary effect must be proportional to the amount of energy absorbed. Hence, the primary effect must be an increase of the energy content of the tissue. Tissue recovery will be considered here as a process tending toward a return to the normal energy content.

The amount of energy absorbed will depend upon many factors and cannot be easily determined, but, for a specific type of radiation, it will be proportional to the amount of energy available. For any specific case it will be proper, therefore, to use a measure of the available energy as a measure of the primary effect. When

treatments are given with radium or radon applicators, the strength of the applicator, in mg of radium or mc of radon, is a measure of the available energy. The usual notation of dosage in mg-hr or mc-hr can serve as a measure of the magnitude of the primary effect produced in the tissue, and also it can serve as a measure of the magnitude of the primary effect remaining in the tissue at any future time.

The fraction of the radiation effect that recovers in unit time is believed to vary with the quality of radiation used. This fraction, which can be called the "tissue recovery constant" and which can be calculated from data given by Weatherwax (2), is 0.044 each day for radiation filtered through 1 mm of platinum, and 0.035 each day for radiation filtered through 2 mm of platinum. The value of the recovery constant used in computing the data presented here is 0.05 each day, which is assumed to be approximately correct for radiation filtered through 0.5 mm of gold or platinum. This value is chosen rather than one of the values given by Weatherwax because the data presented here are meant to apply primarily to treatments given with gold seed implants or with radium or radon needles, most of which have a filtration of 0.3 mm to 0.5 mm of gold or platinum.

THEORY

According to the exponential law of tissue recovery, the rate of tissue recovery is proportional to the amount of effect present. If E , expressed in mg-hr or mc-hr, represents the magnitude of the effect, the excess energy content, at any time, the rate of decrease of E may be expressed mathematically by the differential equation

¹ Accepted for publication April 16 1934

$$\frac{dE}{dt} = -\mu E, \quad (\text{tissue recovery}) \quad (1)$$

where the expression dE/dt is the rate of decrease of E with respect to time, μ is the tissue recovery constant, and the minus sign indicates that the value of E is decreasing. The solution of this differential equation is

$$E_t = E_0 e^{-\mu t} \quad (\text{tissue recovery}) \quad (2)$$

where E_t is the value of E at the end of time t , E_0 is the value of E at the time $t = 0$, and e is the base of the natural logarithms.

When treatments are given with radium applicators, the rate at which the tissue receives energy is constant. The total amount of energy, which may be absorbed by the tissue during any period of time, may be expressed as the product of the strength of the applicator and the time during which it is applied. This is a measure of the maximum possible effect which may be produced in the tissue. This maximum possible effect, E , may be expressed mathematically by the equation

$$E = St \quad (\text{for radium}) \quad (3)$$

where S is the strength of the applicator in mg, and t is the time in hours for which the applicator is applied. The rate, dE/dt at which energy is delivered, is found by differentiating the above equation with respect to time, and is

$$\frac{dE}{dt} = S \quad (\text{for radium}) \quad (4)$$

However, as soon as the tissue begins to absorb energy, the recovery processes commence operating. The rate at which the excess energy content of the tissue is changing during the application of a radium applicator is equal to the difference between the rate at which energy is absorbed by the tissue, as expressed by Equation 4, and the rate at which the tissue recovers, as expressed by Equation 1. Therefore, the true rate dE/dt , at which the excess energy content of the tissue is changing is

TABLE I

Values of doses delivered by a 1 mg tube of radium and a radon tube of initial strength of 1 mc

Days	Mg -hr		Mc -hr	
	Total dose	Saturation dose	Total dose	Saturation dose
1	24	23.4	22.0	21.4
2	48	45.7	40.3	38.3
3	72	68.8	55.7	51.4
4	96	87.0	68.5	61.4
5	120	106.2	79.2	68.8
6	144	124.4	88.1	74.2
7	168	141.8	95.6	77.8
8	192	158.2	101.8	80.0
9	216	174.0	107.0	81.3
10	240	188.8	111.3	81.5
11	264	202.8	115.0	81.2
12	288	216.4	118.0	80.2
13	312	229.2	120.5	78.6
14	336	241.4	122.6	77.0
15	360	253.0	124.4	74.8
16	384	264.4	125.9	72.6
17	408	275.0	127.1	70.3
18	432	284.6	128.1	67.8
19	456	294.4	129.0	65.5
20	480	303.8	129.7	63.0

$$\frac{dE}{dt} = S - \mu E \quad (\text{during application of radium}) \quad (5)$$

The solution of the differential Equation 5 is

$$E_t = \frac{S}{\mu} (1 - e^{-\mu t}) \quad (\text{during application of radium}) \quad (6)$$

in which E_t is the excess energy content at any time, t after the time when E_t and t were zero.

In Column 3 of Table I are given the results obtained by substituting in Equation 6 a value of 1 mg for S and a value of 0.05 each day for μ . These results are shown graphically by Curve A of Figure 1. As the value of E_t increases, the rate of loss of energy due to recovery increases and eventually becomes equal to the rate at which energy is being delivered to the tissue. Theoretically, this state of equilibrium would not be reached until the end of an infinite length of time, when $e^{-\mu t}$ is equal to zero. If the state of equilibrium were reached, E_t would be equal to S/μ , on the other hand, if the excess energy content of the tissue is equal to E_t , this

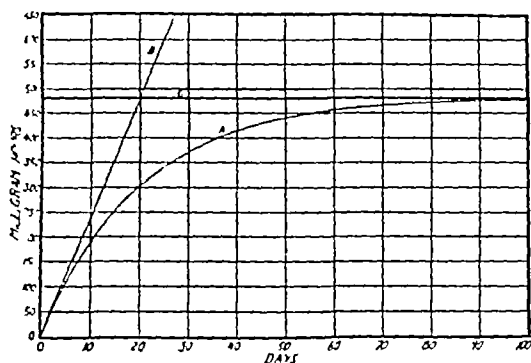


Fig 1 Doses from a 1 mg tube of radium *A* saturation dose *B* total dose *G* saturation dose that can be maintained or maximum saturation dose that can be delivered

excess energy content could be maintained with an applicator of strength such that

$$S = \mu E_t \text{ (radium applicator strength)} \quad (7)$$

When a radon applicator is used, the rate at which energy may be absorbed by the tissue is not constant because the strength of the applicator is continuously decreasing. The maximum possible amount of energy, E , expressed in mc-hr, which may be absorbed by the tissue during a period of t hours can be found from the expression

$$E = \frac{S_o - S_t}{\lambda} \text{ (for radon)} \quad (8)$$

where S_o is the strength of the applicator at the beginning, and S_t is the strength at the end of the period of time t , and λ is the radio-active constant for radon (0.007506 each hour). The value of S_t can be found from the value of S_o from the equation for the decay of radon,

$$S_t = S_o e^{-\lambda t} \text{ (radon decay)} \quad (9)$$

Substituting the value of S_t from Equation 9 in Equation 8,

$$E = \frac{S_o - S_o e^{-\lambda t}}{\lambda},$$

or

$$E = \frac{S_o}{\lambda} (1 - e^{-\lambda t}) \text{ (for radon)} \quad (10)$$

The rate, dE/dt , at which energy is

delivered to the tissue can be found by differentiating Equation 10 with respect to time,

$$\frac{dE}{dt} = S_o e^{-\lambda t} \text{ (for radon)} \quad (11)$$

The rate, dE/dt , at which the excess energy content of the tissue is changing during the application of a radon applicator, is equal to the difference between the rate at which energy is absorbed by the tissue, as expressed by Equation 11, and the rate at which the tissue recovers, as expressed by Equation 1,

$$\frac{dE}{dt} = S_o e^{-\lambda t} - \mu E \text{ (during application of radon)} \quad (12)$$

The solution of the differential equation 12 is

$$E_t = \frac{S_o}{\lambda - \mu} (e^{-\mu t} - e^{-\lambda t}) \text{ (during application of radon)} \quad (13)$$

By substituting the same value for μ , 0.05 each day, as in Equation 6, and 1 mc for S_o , the values shown in Column 5 of Table I were obtained. These results are shown graphically by Curve *AA* of Figure 2. The results obtained for a radon applicator differ greatly from the results obtained for a radium applicator (*A* of Figure 1) because, after a few days, the strength of the radon applicator becomes very small, and the rate of recovery becomes greater than the rate at which energy is delivered to the tissue. A maximum value for E_t is reached about the tenth day, and after about the fortieth day the rate at which energy is absorbed becomes negligible, and the rate of decrease of E very nearly satisfies Equation 1.

The value of t when E_t is a maximum can be found mathematically by differentiating Equation 13 with respect to time, equating the result to zero, and solving for t . The result of this procedure is

$$t_{max} = \frac{1}{\lambda - \mu} \log_e \left(\frac{\lambda}{\mu} \right),$$

or, changed to common logarithms, this equation becomes

$$t_{max} = \frac{2.303}{\lambda - \mu} \log_{10} \left(\frac{\lambda}{\mu} \right) \quad (\text{for radon applicator}) \quad (14)$$

Substituting, in equation 14, the same values for the constants as before, the value of t_{max} is found to be 9.85 days, and the value of E_t , from Equation 13, at that time will be 81.5 mc-hr when S_0 is 1 millicurie

The data presented here have been computed for an applicator strength of 1 mg of radium, and an applicator of initial strength of 1 mc of radon. The values of E_t , or what might be called the saturation dose at any time, for applicators of other strengths can be found by multiplying the proper value of E_t by the strength of the radium applicator or the initial strength of the radon applicator

DISCUSSION

Very little is known about the effects of radiation on tissue and the recovery of tissue from these effects. It is known that some of the effects may appear several months after irradiation and that after comparatively intense irradiation the tissue may never recover. It is known also that long-repeated small doses will eventually produce effects that, according to the exponential law of recovery, should never be produced. Yet it is known that some recovery or return toward normal does take place. It is very logical to assume that the primary effect of radiation, which must be an increase in the energy content of the cells, takes place only during the period of irradiation, and that recovery processes are in action at all times after irradiation is started. That recovery processes are effective is indicated by the fact that the total dose needed to produce a desired effect, such as an erythema of the skin, is greater if given in small quantities over a period of several days than if given at a single time. The fact that it is possible, by means of the exponential

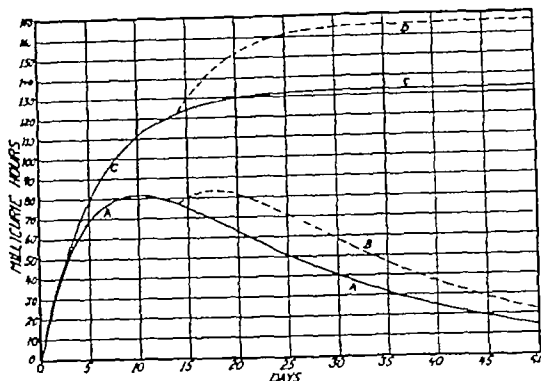


Fig 2 Doses from radon tubes AA saturation dose and CC total dose for tube of initial strength of 1 mc AB saturation dose and CD total dose, for tube of initial strength of 1 mc to which is added a tube of 0.25 mc. on the fourteenth day

law of recovery, to determine the amount of radiation which should be given over varying periods of time to produce such a desired effect is evidence that the exponential law of recovery does describe processes at work in the tissue. Therefore, it may be assumed that the exponential law of recovery approximately describes some of the processes taking place in the tissue after irradiation and may be used safely within certain limits. However, since it does not describe accurately all of the processes set in motion by irradiation, it must be used with caution.

The values of μ , the recovery constant, that are ordinarily used depend only on the quality of the radiation. This variation of μ might be used as evidence in favor of the theory that the effectiveness of radiation in producing various tissue reactions varies with the quality of radiation. However, the value of μ undoubtedly varies also because of many other factors, such as type of tissue, the part of the body in which the tissue is situated, the blood and lymph supply to the tissue, and the volume of tissue irradiated. Until the variation of μ due to other factors is known, it is not possible to determine how much of the variation due to radiation quality is actual or only apparent, and until more is known about the effect of all factors on the value of μ , full use cannot be made of the exponential law of recovery.

APPLICATIONS

In order that the technic of radium or radon therapy may correspond approximately to the saturation technic used in

Curve *AB* shows that the saturation dose reaches a maximum value about the tenth day and remains within 5 per cent of this value until the twenty-third day, and Curve *CD* shows that the total dose

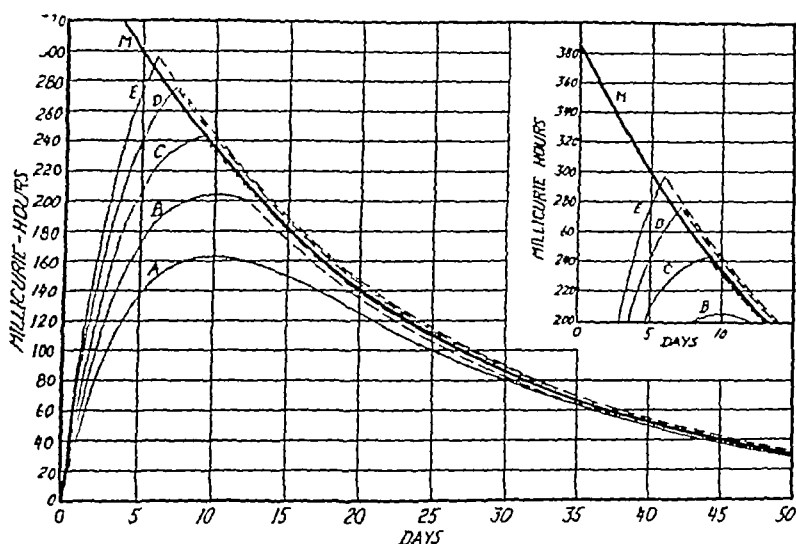


Fig 3 Saturation doses from *A* 2 mc. tube applied permanently, *B* 2.5 mc tube applied for 12.3 days, *C* 3 mc. for 9 days, *D*, 3.5 mc. for 7.3 days, *E* 4 mc. for 6 days. Saturation doses remaining in tissue after removal of tubes are represented by broken lines. *M*, saturation dose remaining in tissue due to a theoretical dose delivered in a very short time when other tubes were applied.

roentgentherapy, the strengths of the applicators should be such that the desired maximum saturation dose will be delivered in from 10 to 14 days. The necessary applicator strength may be determined by dividing the value of the desired saturation dose by the value of the saturation dose delivered by a 1 mg. or 1 mc. applicator during the desired time. The strength of a radium applicator which will maintain this saturation dose can be calculated from Equation 7. It is not possible to maintain a constant saturation dose with radon applicators, but it is possible to maintain a saturation dose within a few per cent of a desired value for a considerable length of time. Curve *AB* of Figure 2 has been drawn from data calculated on the assumption that the strength of an applicator is increased on the fourteenth day by an amount equal to one-fourth the original strength of the applicator. The

reaches a value of about twice the maximum saturation dose. When treatments are given with gold seed implants, it might be feasible to make a second implantation of weak seeds two weeks after the first implantation.

When radium or radon treatments are given within periods of a few hours (generally by means of external applicators), the difference between the total dose and the saturation dose is small, but, when treatments are given over a period of more than a day (generally by means of internal applicators), the difference between the total dose and the saturation dose may be very great. It is known that a dose given with weak tubes may not produce the same effects as an equal dose given with strong tubes. Better correlation between effects produced and doses given might be obtained if the saturation dose were used instead of the total dose. It may be that

to produce some desired tissue effects it is necessary to give an amount of radiation which will produce a definite excess energy content in the tissue at a much later period

It is known that some effects may be produced with total doses which are smaller when given with weak applicators than when given with strong applicators. Qumby (1) has presented data which give the time of application for radon tubes of different strengths in order to produce similar results. One set of this data states that 2 mc. applied permanently is equivalent to 2.5 mc applied for 12.3 days, or 3 mc for 9 days, or 3.5 mc for 7.3 days, or 4 mc for 6 days. By the application of the exponential law of tissue recovery to determine the saturation doses given to the tissue and remaining in the tissue after removal of these tubes, data for constructing the curves in Figure 3 were obtained. These curves show that the saturation dose in the tissue after two or three weeks after the tubes were applied is approximately the same regardless of which combination of tube strength and time was used. The data for Curve M of Figure 3 was computed, by the application of the exponential law to a value of a dose given in a very short time at the time the other doses were started, so that Curve M would approximately coincide with the other curves after the tubes had been removed. The Master Curve M , therefore, represents the saturation dose which should remain in the tissue at any time after the removal of the tubes so as to have an effect produced in the tissue similar to that which would be produced by any of the above combinations of tube strengths and times. Master curves, of course, would have to be determined for reactions desired and for the various types of applicators to be used, but if the dose which would produce the desired reaction for one strength of an applicator were known, the master curve for that applicator and reaction could be computed.

The length of time an applicator should be applied in order that the curve repre-

senting the saturation dose delivered would intersect the master curve, can be determined mathematically. If M represents the value of the master curve at time 0 (385 mc-hr or 16.04 millicurie-days for the data presented here), its saturation value, E_0 , at any future time t can be determined from Equation 2 by substituting M for E_0 ,

$$E_t = Me^{-\mu t} \text{ (Master Curve)} \quad (15)$$

The value of t desired is such that E_t from Equation 15 will be equal to E_t from Equation 6 (if a radium applicator is used), and may be found by equating the right-hand members of these two equations to each other and solving for t ,

$$\frac{S}{\mu} (1 - e^{-\mu t}) = Me^{-\mu t} \quad (16)$$

hence,

$$t = \frac{1}{\mu} \log_e \left(\frac{\mu M + S}{S} \right),$$

and changing to common logarithms,

$$t = \frac{2.303}{\mu} \log_{10} \left(\frac{\mu M + S}{S} \right) \text{ (for radium applicator)} \quad (17)$$

Similarly, by equating the right-hand members of Equations 15 and 13 to each other and solving for t , the time for a radon applicator can be found,

$$\frac{S_0}{\lambda - \mu} (e^{-\mu t} - e^{-\lambda t}) = Me^{-\mu t}, \quad (18)$$

hence,

$$t = \frac{1}{\lambda - \mu} \log_e \left(\frac{S_0}{S_0 - (\lambda - \mu)M} \right),$$

and changing to common logarithms,

$$t = \frac{2.303}{\lambda - \mu} \log_{10} \left(\frac{S_0}{S_0 - (\lambda - \mu)M} \right) \text{ (for radon applicator)} \quad (19)$$

In Table II is given a summary of the differences between values taken or computed from Qumby's data and the theoretical values computed as described above. In only one instance does the theoretical

value differ from Quimby's value by more than 5 per cent. The one exception is that the value for the length of time which the 2.5 mc tube should be applied differs by 12.2 per cent. This difference is not of great significance because the difference in the length of time of application produces only a small change in either the saturation dose or total dose delivered. These differences between Quimby's data and the theoretical values are no greater than the variation in dosage used in practice.

SUMMARY

Equations are presented for applying the exponential law of tissue recovery from irradiation effects to radium and radon dosage. Data which are presented and which apply to applicators of unit strength are computed from these equations by substituting a value of the recovery constant which is assumed to be correct for radiation filtered through 0.5 mm of gold or platinum.

A technic, which will approximately

TABLE II

Values from or calculated from Quimby's data as compared with theoretical values for tubes of same strengths. A 2 mc tube applied permanently, a fifth condition in Quimby's data theoretically should be 2.08 mc, a difference of 4 per cent.

Quimby's data for equal effects	2.5 mc for 12.3 days	3 mc. for 9 days	3.5 mc for 7.3 days	4 mc. for 6 days
Theoretical time	13.8 days	9.1 days	7.0 days	5.7 days
Difference in times	12.2%	1.1%	4.1%	5.0%
Saturation dose in Quimby's time	199 mc-hr	243.9 mc-hr	275 mc-hr	297 mc-hr
Saturation dose in theoretical time	194 mc-hr	244.2 mc-hr	272 mc-hr	291 mc-hr
Difference in saturation doses	2.5%	0.1%	1.1%	2.0%
Total dose in Quimby's time	297 mc-hr	321 mc-hr	341 mc-hr	352 mc-hr
Total dose in theoretical time	306 mc-hr	322 mc-hr	334 mc-hr	342 mc-hr
Difference in total doses	3.0%	0.3%	2.1%	2.8%
Difference between tissue saturation dose curve after tubes are removed and M curve	4.2%	0.7%	3.0%	4.1%

The use of a master curve for calculating dosage would probably be applicable for only limited variations of intensity and time. Since this method of calculating dosage is derived from the application of the exponential law of tissue recovery, it would be limited by how accurately this law describes conditions following irradiation. The application of the exponential law of tissue recovery to data presented by Quimby indicates that some reactions which follow irradiation depend on the giving of an amount of radiation in such a length of time that it will produce a definite saturation effect in the tissue at a definite time after the irradiation is begun. Within what limits the strength of the applicator and the time of application can be varied must be determined clinically.

correspond to the saturation technic used in roentgentherapy, is suggested for giving long radium and radon treatments.

A method is given for computing the necessary length of time of application, for radium and radon applicators of different strengths, to produce the same tissue reactions. The results obtained suggest that an important factor in dosage may be to give an amount of radiation which will produce a definite saturation dose in the tissue at a definite time after irradiation is begun.

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X-RAY THERAPY OF CARCINOMA OF THE LIP AND SKIN¹

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THE Brooklyn Cancer Institute, a unit in the Department of Hospitals of New York City, cares for patients received from other hospitals or referred by its own staff of physicians. The hospital beds at our Institute are limited to the care of those cancer patients requiring urgent surgical or radium therapy. Chronic cases are sent to the Welfare Island Custodial Cancer Hospital. Due to the present necessity for economy and because our bed service is limited, we have found x-ray therapy the most efficient method of treating these ambulatory cases. In many instances such treatment is given with radium emanation.

Generally speaking, the radiosensitivity of any cell, including the tumor cell, is in direct relationship to its nuclear or chromatin substance. The usual basal-cell growth is rich in chromatin substance, and, being on the surface, an exact dose can be given without fear of injury to overlying structures, while if a non-penetrating or long wave length x-ray beam is used, damage to deep structures may be avoided.

The relative penetration of the x-ray into tissues has been carefully worked out by physicists and roentgenologists, for instance, the estimation of the half value layer in aluminum by William H Meyer (1) and the penetration of x-ray beams of different voltages as measured in a water phantom by J L Weatherwax (2).

Measurement of the biologic reaction in absolute roentgens (3) showed a variation with unfiltered rays of longer wave length from 400 r, increasing with harder filtered rays to 700 r, as marking a threshold erythema, without backscattering. This has led to a most accurate estimation of

dosage to the surface plus a good estimation of the depth in tissues.

In spite of these accurate physical and biologic comparisons, it has been demonstrated definitely that much more than one surface erythema dose is necessary to produce a normal erythema to a lesion 2 cm or less in diameter. This increased tolerance is carried up the scale in larger doses which would normally give vesiculation and total destruction, a knowledge of which has been taken advantage of by F Liberson (4), who treated deeper lesions with increased doses of x-radiation without injury to the overlying skin.

J M Martin (5) compared the results following surgery and his own results in radiation in lip and mouth cases, reporting a large percentage of five-year cures.

B P Widmann (6) demonstrated how the underlying structures will tolerate very large doses to the surface, as high as 35 skin erythemas in a single case. This irradiation was delivered in divided doses, being given over relatively large areas.

The present report covers a group of cases composed of all types of epitheliomas of the skin and lip. All these cases received one massive dose either at one time or in two parts on consecutive days, 4,500 r units, or the equivalent of ten threshold skin erythemas, being delivered to the skin area, which was carefully blocked by lead rubber to within 0.5 cm of the edge. On all superficial lesions the factors used were the equivalent of a 6 $\frac{1}{2}$ -in point gap, or 100 peak kilovolts, 5 milliamperes, filter 0.5 cm of wood, estimated to act as a filter of less than 0.5 mm of aluminum, the focal skin distance being 50 centimeters. Since we feel that the overlying cancer cells are acting as a filter, protecting the deeper structures, no cauterization or curettement of the lesion is done. It is surprising how quickly the average

¹ Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City Nov 28-Dec 1 1932

lesion starts filling in after such radical therapy, with little or no deformity. The scar is soft and, except in very large lesions,

treatment. A sluggish ulcer, remaining in a portion of the scar, is sometimes given a small dose of from one-fourth to



Fig 1-A Epidermoid cancer of the lip



Fig 1-B Same case after treatment

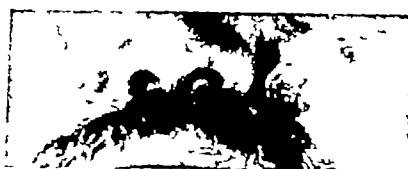


Fig 2-A Basal-cell epithelioma of the cheek

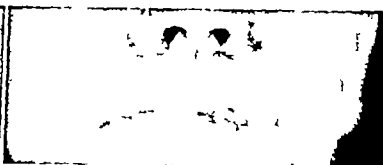


Fig 2-B Same case after treatment

no telangiectatic degeneration of the small blood vessels occur. As an illustration, one female patient of advanced age had a basal-cell lesion measuring 4 inches in its greater diameter, involving one side of the neck and extending up into the scalp behind the ear. It was treated by different types of radiation and coagulation, all to no avail. With the application of the above-described γ -radiation, the lesion healed entirely, without skin graft or other effort, leaving only a few small telangiectatic areas in a pale soft scar. This case has remained healed for over two years.

In one case only was a persistent denudation present. This was a large sarcoma of the soft tissues of the thigh, which had been operated upon twice. Later this patient was treated at another hospital and subsequent biopsies showed no evidence of malignant cells.

For deeper lesions, a similar dose is employed, using a $9\frac{1}{2}$ in point gap or 132 peak kilovolts, filtered through 0.5 cm of wood with 1 mm of aluminum additional.

Few cases need more than the one

one erythema, depending upon its duration and clinical appearance.

We have found that lesions on the scalp are most radioresistant, especially if they are deep-seated. These are often atypical in their pathologic structures, many containing certain glandular alignment of the cells. While they not uncommonly become smaller after treatment, there remains usually a small non-healing ulcer, biopsies of the edge of which show only scar tissue. Could these resultant ulcers be cared for by plastic surgery?

Melanotic lesions are as a rule most radioresistant and, though the local lesion may be destroyed, metastases have usually developed in other parts. These secondary lesions appear to have no relation to γ -radiation of the original lesions, but have either metastasized spontaneously or as a result of previous manipulation.

The third type most resistant to this form of radiation are the squamous-cell lesions of the extremities, which often require at least twenty skin erythema doses. The danger of widespread dissemination in these cases is great. One case with a

primary squamous-celled lesion on the heel of a young woman was entirely healed after the application of 20 skin erythema

tive biopsies The youngest was a female, 19 years of age, with a basal-cell lesion on the face The oldest was a male, 88

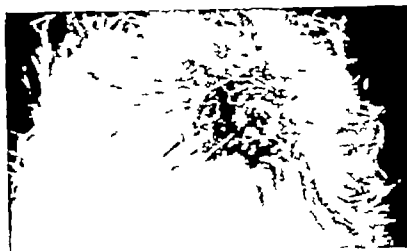


Fig 3-A Epidermoid cancer of the scalp



Fig 3-B Same case, after treatment

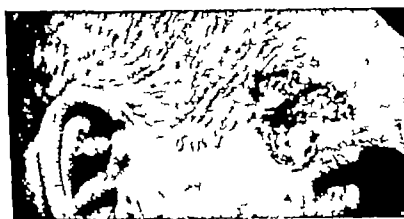


Fig 4-A Basal-cell epithelioma



Fig 4-B Same case, after treatment

doses Over a year later she was admitted to another hospital where she was operated upon for an abdominal tumor, which proved to be due to large secondary retroperitoneal metastatic nodes She was returned to our service, where she died A careful autopsy disclosed a dissemination more general than miliary tuberculosis

The small squamous-celled lesions of the lower lip are most responsive to this type of x-ray treatment and the prognosis is good, provided cervical glands have not developed The technic used is a $9\frac{1}{2}$ -in gap, equivalent to 132 kilovolts, 5 milliamperes, filtered through 0.5 cm of wood, blocking the intrinsic structures of the mouth with lead rubber All infected teeth are removed before therapy is begun These cases are always followed up with a course of roentgen-ray therapy to the lymphatic nodes of the neck Infections in the mouth have at times resulted in serious necrosis and osteitis of the jaw

Statistics —All cases reported have posi-

years of age, with a basal-cell lesion on the face

Six lip cases with positive biopsies have been treated, three in 1931 and three in 1932, only one, treated in October, 1932, is registered as unimproved None of these cases had cervical metastases and no metastases have developed, all having received therapy to the cervical glandular areas

In 1930, seven basal-cell tumors were treated and two of the squamous-cell type one patient had multiple basal-cell lesions Four of these cases are classed as healed, three were not traced but noted as improved One patient had a squamous-celled lesion on the sole of the foot, for which later he had his foot amputated because the lesion did not heal He died less than one year later from metastases One lymphosarcoma of the neck is healed and the patient shows no evidence of other lesions One lymphosarcoma of the thigh shows persistent ulceration Fourteen basal-cell lesions were treated in 1931,

of which ten are noted as healed, one patient died. Four cases were not traced, but noted last as improved.

Of the other pathologic groups, one squamous-cell lesion of the shoulder has remained healed without evidence of metastatic lesions. One adeno-cystic-carcinoma of the scalp is only improved, but biopsies of its edge are negative for cancer cells. One squamous-cell lesion of the arm has healed following 20 skin erythema doses, but the woman has developed metastases in the axilla. One large epidermoid carcinoma, originating in a tremendous burn scar of the back, has not been improved.

SUMMARY

1 An efficient, inexpensive method of treating large numbers of patients who apply to the usual free cancer clinic is given.

2 The *rationale* of this method is backed by physical measurements and previous clinical and radiation reports.

3 Eight to ten erythemas are given, us-

ing a practically unfiltered x-ray beam of little penetration.

4 It is important to carefully block to the lesion, and to estimate the depth of all lesions.

5 This method is not complicated by association with surgery, electrocoagulation or other treatments.

6 The results appear comparable with other acceptable forms of treatment.

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OBJECTIVE OTOLOGIC ROENTGEN STEREOSCOPY AND ITS SIGNIFICANCE FOR THE ROENTGEN DIAGNOSIS OF DISEASES OF THE MASTOID PROCESS¹

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ROENTGEN technical improvements in the demonstration of the temporal bone, especially its petrous portion, still are welcome as the exploration of this area, due to its complicated structure, is

sufficient for satisfactory demonstration of all detail desirable. The Schuller projection furnishes a good survey of the entire pneumatic system, the course of the venous sinus, and the ala of the temporal

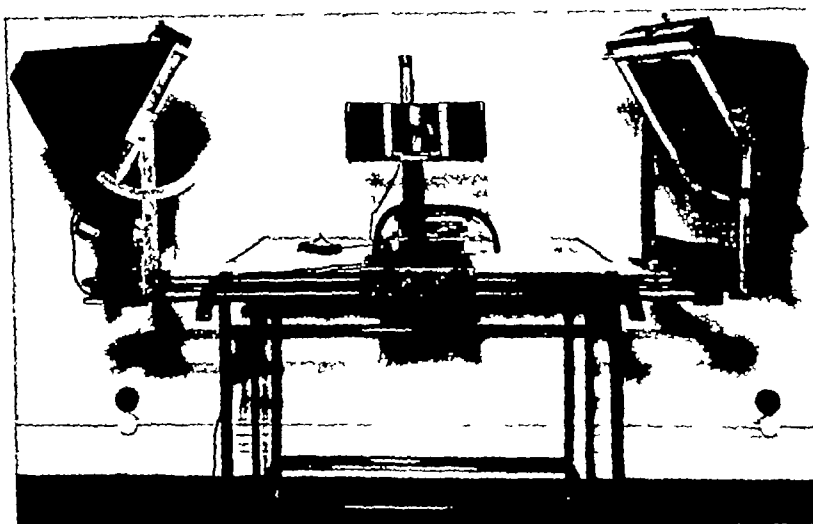


Fig 1

quite difficult. Any methods permitting of correct identification and spatial correlation of the various superimposed structural shadows deserve critical evaluation. It is presupposed in this paper that the reader is familiar with various typical projections of the temporal bone, especially those devised by Schuller, Stenvers, and Mayer, furthermore, that he is familiar with the principles of roentgenstereoscopy.²

The three special projections of Schüller, Stenvers, and Mayer are regarded as suf-

ficient for satisfactory demonstration of all detail desirable. The Schuller projection furnishes a good survey of the entire pneumatic system, the course of the venous sinus, and the ala of the temporal bone, the apex of the mastoid process also may be readily differentiated. The Mayer projection demonstrates to best advantage the spaces of the middle ear, especially the attic, and the mastoid antrum, while the Stenvers projection is chosen when information is desired concerning the apex of the pyramids, the labyrinth, and the tegmen. All other projections—more than twenty have been recommended in the roentgenologic-otologic literature—may be omitted without sacrifice, when correct stereoscopic projections in the three types mentioned, are secured.

Tautomorphic roentgen stereoscopic dem-

¹ Accepted for publication July 17 1933
² See Jarre and Teschendorf, RADIOLOGY August, 1933 21, 139

onstration of the temporal bone with any of the common oblique projections has not been described previously, though, of course, stereoscopic procedures, as, for instance, inherently incorporated into the

pension of these viewing boxes in a fork, mounted on their usual supports, will easily accommodate for all necessities, especially when suitable calibration in the horizontal and vertical planes are incor-



Fig 2

Reaves "Radiographscope" and the Haselwander "Stereoskiagraph," point toward correct application of physical laws with such projections. As long as it is possible to reproduce conditions of projection during visual observation of stereoscopic images, all distortions due to oblique projections may be visually eliminated so that correct spatial relationship is not only perceived but may also be proven by stereoscopic measurements. Therefore, if one will record the angles of inclination, besides all other stereoscopic data, if one, furthermore, will devise a viewing apparatus, permitting of a reproduction of such angles, then correct spatial evaluation is possible.

Many of the tube stands commonly in use for roentgenography are equipped with calibration, which permits one readily to record any angle of inclination of the inciding roentgen-ray beam. Roentgen stereoscopes commonly in use have no such calibration, many of them permit of a rotation of the viewing boxes around a vertical axis in a horizontal plane, but they do not permit of an inclination of these boxes around a horizontal axis. Sus-

porated (Fig 1) Correct focussing devices on the stereoscopes and marking of the axial rays on the stereo images are essential. All projections of the temporal bone preferably are obtained with the use of a long narrow cone rather than with a Bucky diaphragm. Care must be taken that the tube shift is performed parallel to the plane of the film.

We are not unmindful of the fact that acute inflammatory disease of the mastoid process, analogous to acute infectious processes of other portions of the skeletal system, not infrequently may cause considerable difficulty and uncertainty in roentgen diagnosis. In the early stages of the disease, when diagnosis is so essential, one may often notice merely a diminution of air content of the cells of the mastoid without evident destruction of intercellular septa. An extensive bronectrotic condition of the bony trabeculae may then surprise roentgenologists and surgeons. An exclusive, clear-cut diagnosis, or clear-cut roentgen indications for operative interference cannot be expected in all cases of early acute osteomyelitis of any portion of the temporal

bone, any more than it may be hoped for in all cases of early osteomyelitis in any other bone. History and clinical observation will have to be taken into consideration, together with, or eventually regard-

A few illustrations and case histories may emphasize statements made. The first case cited is one of acute otitis media of three weeks' duration. Mild sagging of the posterior wall of the auditory canal



Fig 3



Fig 4

less of, roentgenologic appearance. The symmetrical and well pneumatized mastoid process, of course, offers better chances for roentgenologic diagnosis than the irregular mixed type of pneumatization, though stereoscopic visualization may be of material aid in the recognition of spatial relationship and differentiation of various structures.

was present. There was marked soreness of the entire mastoid, on palpation. Projection according to Schuller (Fig 2) shows well pneumatized mastoid process, all cellular structures clouded. Only cells in the region of the sinus are aerated to a somewhat better degree. A large space overlying the sinus represents a large mastoid cell and not an area of destruction.

Cellular septa above the mastoid antrum and toward the angle of the petrous portion are extensively destroyed. No clear-cut osseous structure can be recognized in this region. The operative findings were

evacuated by rinsing of the ear. Projection according to Mayer (Fig 4) shows. Rather sclerosed mastoid process, a large cavity of more than hazel-nut size may be recognized above the acoustic meatus to-

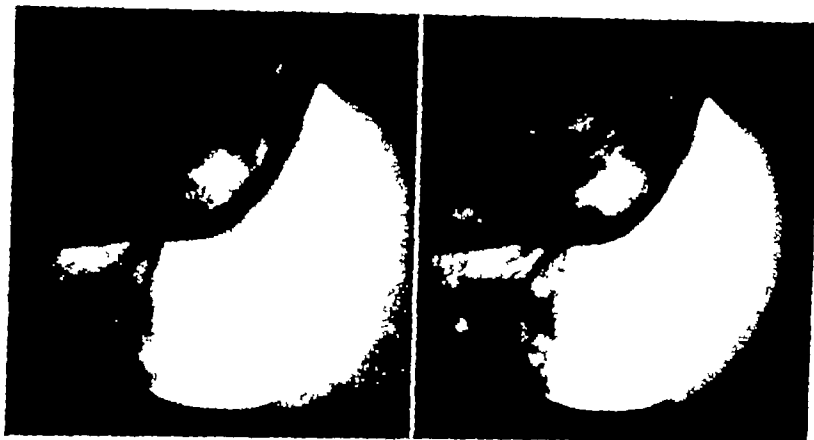


Fig 5

All cells are filled with pus, small areas of destruction are found in the tip of the mastoid and, furthermore, between the mastoid antrum and the angle of the petrous portion, no involvement of the area surrounding the sinus.

The second case is that of a child six years old, with a running left ear of several months' duration. Projection according to Schuller (Fig 3) shows. Small mastoid process with little pneumatization. On stereoscopic exploration one can detect a large cavity of nearly hazel-nut size, deeply situated between the acoustic meatus and the angle of the petrous bone. The mastoid antrum apparently is entirely replaced by this cavity. An additional small area of destruction is found in the region of the tip of the mastoid process. The area of destruction apparently is extending close to the sigmoid sulcus. Stereoröntgenologic observations were entirely confirmed at operation.

The third patient, H. D., 19 years old, had had a running ear since childhood, with foul secretion. There is a marginal perforation of the drum through which fetid masses from a cholesteatoma can be

ward the angle of the petrous bone, believed to represent the much enlarged mastoid antrum, the osseous acoustic meatus appears to be much thinned out. The diagnosis of cholesteatoma was confirmed at operation.

The last patient whose case is cited is H. M., aged 46, who, since childhood, had had a periodically running left ear. The acoustic meatus is narrowed to a small slit by a markedly circumscribed protrusion of the upper posterior wall and, in addition, by a pedunculated polyp. Gumma was somewhat suspected. Projection according to Stenvers (Fig 5) shows. A large cavity extending to the upper border of the pyramid, while the inner acoustic meatus and the area of the labyrinth reveal no roentgenologic changes. On account of the well demarcated delineation of the large cavity, cholesteatoma was diagnosed, which assumption was well confirmed at operation.

CONCLUSIONS

Stereoscopic exploration of the temporal bone improves diagnostic evaluation considerably. Typical projections—prefer-

ably according to Schüller, Stenvers, and Mayer—cannot be dispensed with, they are as essential for stereoscopic as for single-film demonstration of various detail. Stereoscopic images must be obtained “objectively correctly.” By observation under corresponding angles, distortions due to the oblique projections may be compensated for and visually eliminated. This valuable and instructive correction of distortion cannot be regarded as a complication of the method—the angulations of the tubes for the various oblique projections are known and correct adjustment of the visualized records is, therefore, readily accomplished.

Note—The accompanying reproduction may be viewed in nearly correct proportions if the book-stereoscope is held at such an inclination to the plane of the images that the viewing direction approximately equals that of the projections. The projection of Schüller thus entails an angle of about 120 degrees, the one of Mayer an angle of 135 degrees. This, however, does not completely reproduce the effect of tautomorphic orthostereo-

scopy, as is possible with a proper stereoscope and films.

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ROENTGEN FINDINGS IN SMALL STOMACH LESIONS COMPARED WITH INTRAGASTRIC PHOTOGRAPHS OF THE LIVING SUBJECT¹

By P E THAL, M D , *Chicago*

CLOSER co-operation of gastro-enterologists and surgeons with roentgenologists, and their untiring efforts to improve the technic and the diagnostic value of their findings has resulted in the

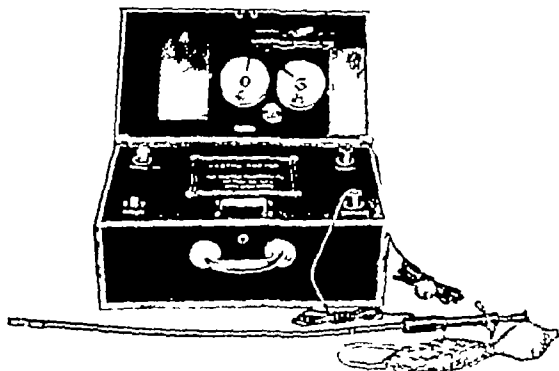


Fig 1 Gastro photor apparatus

recognition of gastric pathology much earlier than was possible a few years ago. To-day many small deviations from the normal shadow on the skiagram, which were overlooked in the past, are of definite diagnostic value to us.

From year to year, the percentage of negative roentgen findings in patients with positive symptoms, is becoming less and less. Much suffering and expense is spared the patient as a result of an early and accurate diagnosis, made possible through the ever-increasing efficiency of roentgenology. Yet, in spite of all of the success that has crowned our efforts, we cannot feel that we have attained perfection and are often confronted with the painful realization of the inherent limitations of roentgenography and are ever on the lookout for means to improve the value of our findings.

The permanent record furnished by the roentgenograms has played no small part in

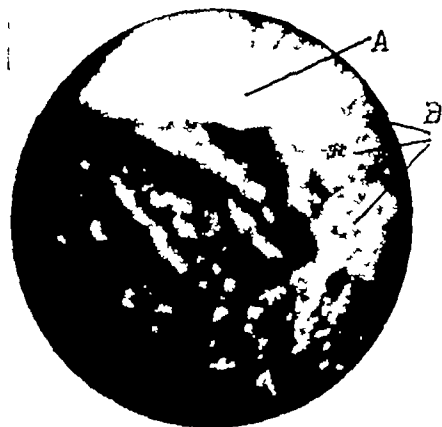


Fig 2 An intragastric photograph of a patient with moderately acute symptoms. The roentgen examination revealed gall bladder pathology but the stomach findings were indefinite except for showing marked spasticity near the pylorus. The photograph shows a spastic fold at A and a series of small ulcers or erosions at B which no doubt caused the stomach symptoms and produced the spasticity. From the appearance of this pathology, a resection was not deemed necessary. However the stomach was explored while doing a cholecystectomy and the lesion confirmed.

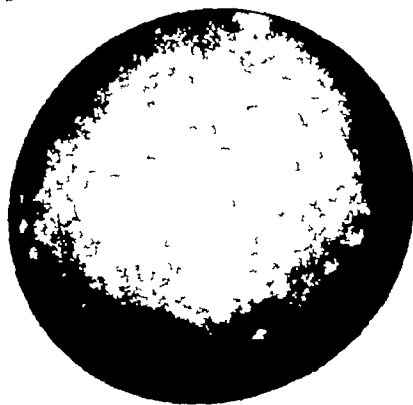


Fig 3 A patient whose symptoms were very acute. Roentgen examination showed marked gastric irritability and rapid emptying. The photograph shows two round ulcers which not only convinced the doctor but also the patient making proper treatment possible.

¹ Presented before the Radiological Society of North America at St. Louis Nov. 30-Dec. 4 1931.

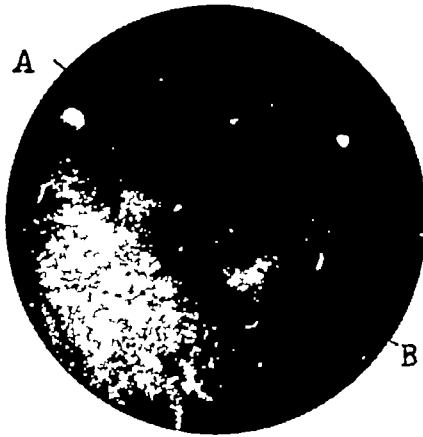


Fig 4 A patient whose skiagrams showed a typical incisure of the greater curvature which we have always looked at as evidence of pathology in the opposite region of the lesser curvature. The photograph shows a small but deep ulcer on the lesser curvature at A and a smaller and more superficial erosion near by at B

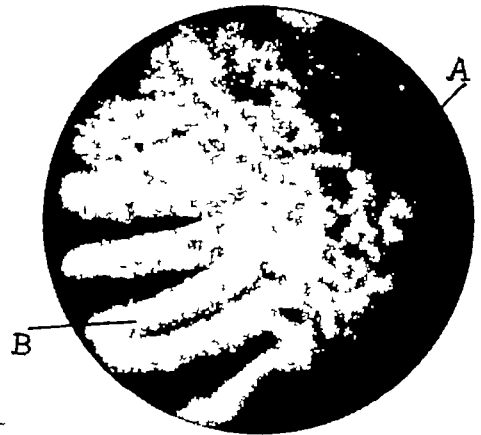


Fig 6 An intragastric photograph of a patient who had a partial gastrectomy a few years before. A section of the scar at A and the marked corrugation of the stomach wall at B are readily disclosed

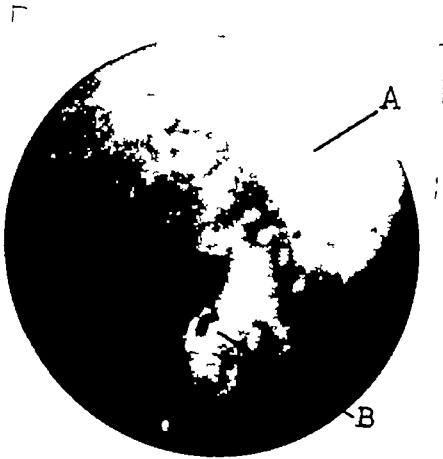


Fig 5 A patient with moderate and indefinite gastric symptoms. Roentgen findings showed spasticity but no definite pathology was seen. The photograph shows a spastic fold at A and a small round ulcer at B

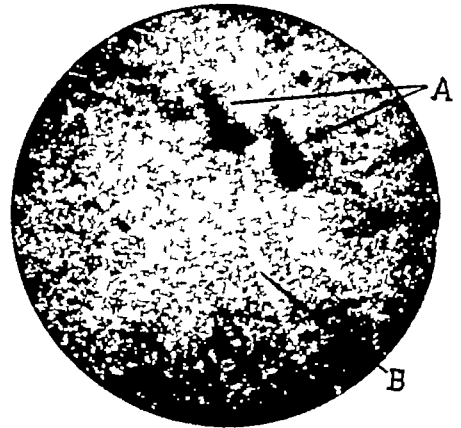


Fig 7 A patient whose roentgen findings were quite indefinite but his symptoms were very persistent. The photograph shows two small but very deep ulcers at A B shows the rugae converging into the pylorus. This lesion was confirmed at operation and the patient became symptom free after a gastroenterostomy

making roentgenology popular and dependable. The information obtained by fluoroscopy is of inestimable value but sometimes it is difficult to convey a vivid word picture of what we see to the internist.

Actual visual inspection of any part under examination has always held first place in diagnostic value. For example, many elaborate systems of roentgen ex-

amination of the urinary bladder have been devised and practised, yet what we can see through the cystoscope is invaluable.

Visualization of the gastric mucosa has been an unsatisfied desire of the gastroenterologists of all times. It is the purpose of this paper to briefly discuss the attempts made in the past to see the inside of the stomach and to show the results obtained by photographing its interior,

with the view of learning what of value can be added to our diagnostic information

Long before the discovery of the roentgen ray, various, more or less successful, attempts were made at gastroscopy. The

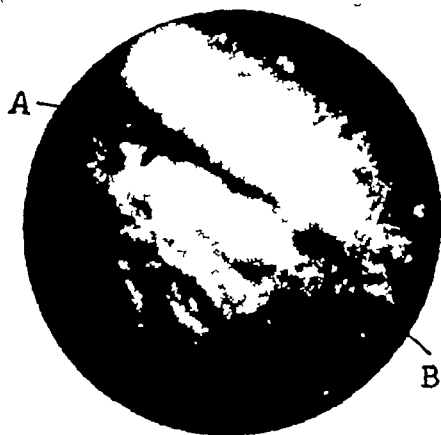


Fig 8 At A, is shown the photographic appearance of a gastroenterostomy opening about 18 months after the operation. B shows some small erosions at one end of the opening.

difficulties encountered in this, and the limitations of its diagnostic value are many. It is a procedure of utmost discomfort and carries a much higher risk of injury to the patient than any other diagnostic instrumentation that is in use to-day. The introduction of a straight rigid instrument through the esophagus, around the base of the heart, and through the cardiac orifice of the stomach, necessitates pulling these structures out of their normal alignment. The irritation of this causes the stomach to convulsively contract. Attempts to inflate the stomach under such conditions are only partially successful. Usually, as one portion is dilated under air pressure other portions are in a state of spastic contraction. Under these conditions the stomach cannot be uniformly inflated or made to remain more or less still so that a careful inspection of its interior can be made. Because the views seen through the gastroscope are fleeting and are in focus for only a brief moment,

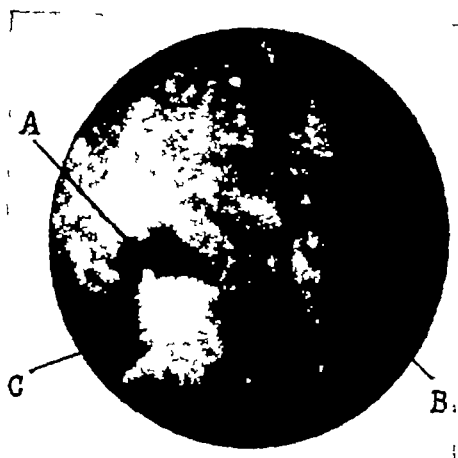


Fig 9 A photograph of the pyloric region of a patient whose roentgen examination showed abnormal spasticity in the lower part of the stomach and a filling defect in the prepyloric region suggesting the presence of a mass which was diagnosed as a probable carcinoma. A shows the pylorus in the background partially obstructed by a mass of redundant mucosa. C. At B we see a small ulcer on the border of the spastic fold.

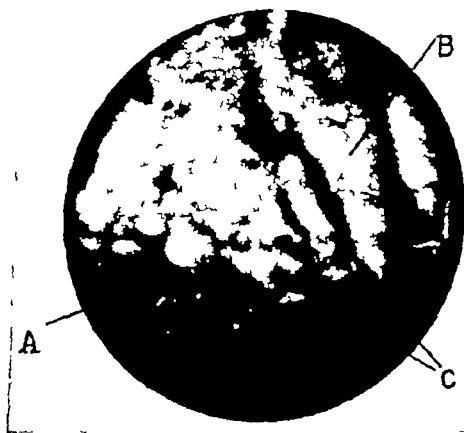


Fig 10 A photograph of a section of the prepyloric region in a man 69 years of age whose son was a physician. Roentgen examinations had been made at two different laboratories in other cities and a diagnosis of carcinoma was made by both, but the photographs showed a deep cicatricial deformity at A, spasticity and interruption of rugae at B, and small ulcers at C. Numerous other views were made which convinced us that we were dealing with a benign condition and proper treatment was instituted which gave complete relief. It is now three years since the treatment was given and the patient is alive and enjoying the best of health.

it is difficult to get an accurate idea of the general appearance of the interior of the stomach.

The earliest attempts to photograph the interior of the stomach, of which we have any record, were made in 1885. However, the instruments were crude and unwieldy and gave no better results than those obtained by gastroscopy. These earliest

attempts were made in order to secure views of the entire stomach. No patient could stand such an ordeal and it was impossible to inflate the stomach satisfactorily because of the rigidity of the instrument. Little progress was made in this field until six or seven

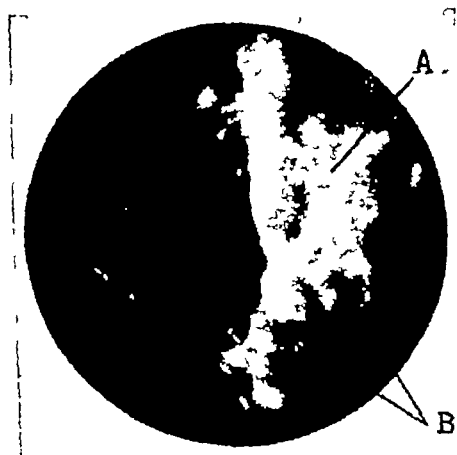


Fig 11 A patient whose roentgen examination showed spastic folds. At A, we see the photographic appearance of such a fold, at B the ulcers, confirming the assumption based on the roentgen evidence.



Fig 13 A photograph of relatively normal rugae converging toward the pyloric region in the lower border of the picture.



Fig 12 A photograph of the pylorus at relatively long range. No pathology is disclosed.

cameras designed for intragastric photography were rigid tubes, equipped with a single lens, required long exposures, and covered only a small field at each exposure. The idea was to move the camera up and down and turn it in the different direc-

years ago when Dr. Heilpern, of Vienna, revived the subject. He was assisted by Mr. Back, who worked out the mechanical problems. They developed a very simple and relatively efficient instrument (Fig. 1) by which they were able to obtain gratifying results.

As I used this instrument in the work of forming the basis of this paper, it may be well to give a brief description of it, as well as the technic of its use.

The instrument consists of two cameras, one placed above and one below an illuminating bulb. The entire assembly is small enough to be passed into the stomach with ease. Each one of these cameras has four film chambers arranged so that one film is directed toward the right, one toward the back, one toward the left, and one toward the front of the stomach. This arrangement enables us to secure eight exposures simultaneously, making two views of the lesser curvature, two of the posterior wall, two of the greater curvature, and two of the anterior wall. The camera as-

sembly is attached to the end of a small flexible tube through which the manipulating mechanism and the lighting wires pass. This tube is small and flexible enough so that it does not cause any irri-

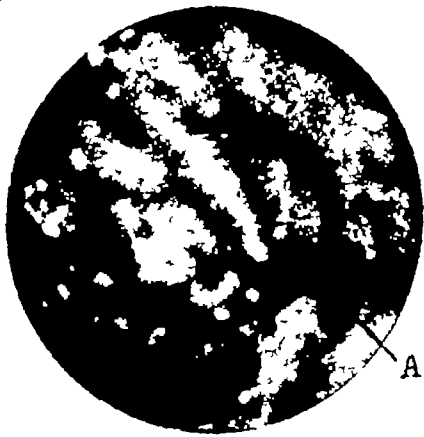


Fig 14 Here is shown the deformity of the rugae from cicatricial contraction surrounding a small ulcer at A. Roentgen findings were rather uncertain.

tation in the esophagus and readily conforms to the curvature of the cardia. This makes its use a procedure which is easy on the patient, and a complete inflation of the stomach is therefore possible.

The technic is quite simple, the patient presents himself with a fasting stomach, the small amount of fluid, usually found in the stomach, is removed with a tube. The camera is introduced into the stomach in the same manner as the passing of a lavage tube. This is done under fluoroscopic control which enables us to focus the camera on the region of principal interest and to see when the degree of inflation is proper. When all is set, the exposure is made by opening the shutter and flashing the light bulb. Now the camera is withdrawn and the films are treated like any photographic negatives.

Owing to the extremely short focal length of the camera, which makes use of the "pin-hole" principle, we have a much reduced image on the negatives. These



Fig 15 A photograph of normal rugae. The uniform angulation seen through the center is brought about by a deformity of the stomach caused by an operation.

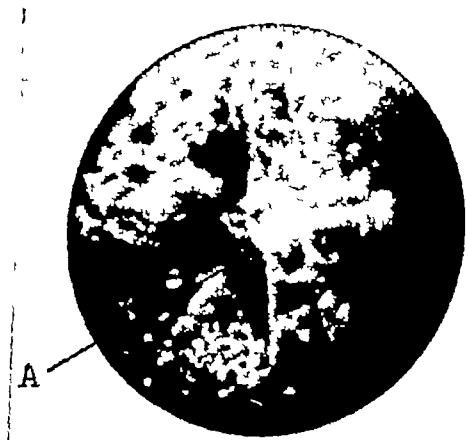


Fig 16 Here is shown a cicatricial deformity at A. The roentgen examination showed a filling defect which was interpreted as an acute ulcer.

are brought back to convenient size by the use of an ordinary enlarging process as in the making of photographic prints. The entire procedure takes only a few minutes and can be run conveniently just before starting the gastro-intestinal series. By the time the roentgen series is completed, the finished photographs are ready to add what they may to our diagnosis.

Time does not permit giving detailed case histories, or the showing of all of the films made in each case, and to select just one and claim to prove any point by it.

might be misleading. It is understood of course that all of the patients had the clinical symptoms which called for roentgen examination. Because you are all so familiar with the roentgen findings, I believe that it will be sufficient just to allude to them, showing you in detail the results of intragastric photography.

It is understood of course that, regardless of how perfect a photographic reproduction we could secure of the interior of the stomach, there would still be much valuable information, such as the size, general contour, position, peristaltic activity, emptying time, etc., which could only be secured by the roentgen examination.

CONCLUSIONS

Intragastric photography has consis-

tently confirmed the indirect roentgen evidence of pathology.

(1) This was especially constant when the symptoms were of short duration.

(2) In many instances it served to clear up questionable points.

(3) It shows small and superficial lesions which escape roentgen detection.

(4) It can be carried out with ease and safety to the patient.

(5) It is at present the best means available for visualizing the gastric mucosa.

(6) When taken in conjunction with the roentgen examination, it adds valuable information to our diagnostic picture.

THE EFFECT OF ROENTGEN-RAY EXPOSURES OF THE CEREBRAL CORTEX ON THE ACTIVITY OF THE CEREBRAL HEMISPHERES

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WHEN the effect of roentgen rays on the animal and human organism was revealed the attention of investigators was naturally directed to the nervous system, namely, the cerebral cortex. Nevertheless the numerous investigations along these lines have produced little better than negative results. At any rate, they did not succeed in establishing either histologic changes in the cerebral tissue or degenerative changes in the ganglion cells of adult animals (Sicard, Bauer, Labeau, Walter and others). Experiments carried out in connection with the exposure of new-born animals proved to be exceptions, for here a number of workers (Krukenberg, Foersterling, Nemenow, Mogilnitsky, and Podliashuk) observed a marked backwardness in the brain development of exposed animals. My studies of the effect of heavy dosage of roentgen rays on the brain of mice and guinea pigs have also mostly shown negative results.

I have often asked myself whether roentgen rays actually had no effect on nerve cells or whether the nature of the changes produced was such that we are unable to observe them by such means as are now available.

To me, the latter consideration seemed to account for the fact. Indeed, the microscope we use is but a crude instrument if we consider the elements of which the cell is composed, *i.e.*, molecules and atoms. On the other hand, we observe a series of mental diseases which are considered to be functional disturbances of the cerebral activity. These include, for instance, hysteroneurasthenia, circular insanity, etc., and are regarded as functional psychoses merely because their anatomic substrate remains unknown.

The question arises: can the conception

of a function without an anatomic substrate be in harmony with our materialistic outlook?

Any function, either normal or pathologic, has a definite corresponding physicochemical substrate, a certain morphology, and a change in the function necessarily depends on the change of the substrate.

Having accepted this hypothesis, which should be essential to every investigator in the field of natural sciences who is possessed of a materialistic outlook, I came to the conclusion that, if we are unable to establish subtle changes in the structure and physicochemical condition of the cells, we still can attempt to establish the changes in the function of these cells. If we are unable to establish the histologic changes caused by roentgen rays in the ganglion cells of the cerebral cortex, is it not possible to establish changes in the function of these cells subsequent to the exposure of the brain to roentgen rays?

It is to the fundamental work of I P Pavlov that we are indebted for the method of investigating the activity of the hemispheres of the cerebral cortex. Pavlov's method consists in studying the conditioned reflexes. The method is so accurate, subtle, and refined that I am sure if there are any changes occurring in the function of the cerebral cortex due to the exposure of the brain to roentgen rays, they will be revealed by the method of conditioned reflexes.

Only in the Autumn of 1927 did I at last succeed in carrying out my intention. I P Pavlov kindly met my desires half-way and permitted me to use both his laboratory and his trained experimental animals for my work. I shall now take the liberty of describing in brief the es-

sence of the method of studying conditioned reflexes for the benefit of such of my comrades as may not yet be familiar with it

By the term reflex, we mean the gen-

when food is introduced The mere sight of food, the movements of the person making it ready, its smell and all that refers to food serve to produce salivation in a greater or lesser degree In this case the

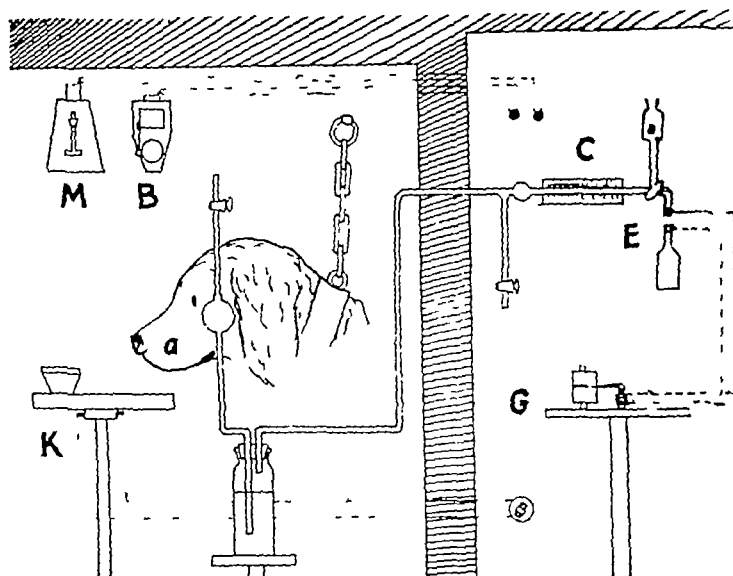


Fig 1 Scheme of chamber with a dog in it during the experiment (a) Rubber bulb attached to the fistula (D) scale, (E) point of closing the circuit, (G) graphic apparatus (K) feeding trough, (M) metronome, (B) bell

erally known physiologic process which consists of (1) the reception of external irritation by our senses, (2) the transformation of the energy of the stimuli into nervous energy which is conveyed by the nerves to the centers of the cerebral cortex and the spinal cord, (3) the transmission of nervous impulses from these centers to this or the other organ, either motor or secretory

Thus, for instance, food introduced into the animal's mouth cavity transmits the irritation from the nerve plates of the mucus along nerve stems to the center of salivation, located in the medulla oblongata, and from there the nervous impulses are conveyed to the secretory nerves of the salivary glands. This results in salivation (unconditioned reflex, conditioned salivation)

However, the reflex occurs not alone

reflex is transferred by the retina, the nerve plates in the mucosa of the nose, the external auditory apparatus (the sound of the utensils being moved, etc)

Besides, if simultaneously with the administration of food we introduce some other stimulus which is in no way connected with food and may even be so far unknown to the animal (the sound of a bell or metronome, for instance), and repeatedly coincide this stimulus with the administration of food, the effect of the stimulus alone preceding food will produce salivation. These reflexes caused by spontaneous (conditioned) stimuli have been called by Pavlov "conditioned reflexes"

If the conditioned reflex is somewhat varied, as, for instance, if the metronome is set at 60 beats per minute instead of the previous 120 beats, and if no food is then given to the dog, the animal learns to

differentiate between the two stimuli and does not respond by salivation to the metronome set at 60 beats. Thus, according to Pavlov's term, differentiated inhibition is formed.

and the rubber tubing attached to it being completely filled with water. A drop of saliva upon entering the bulb produces a shifting of the liquid in the system of rubber and glass tubes which are provided

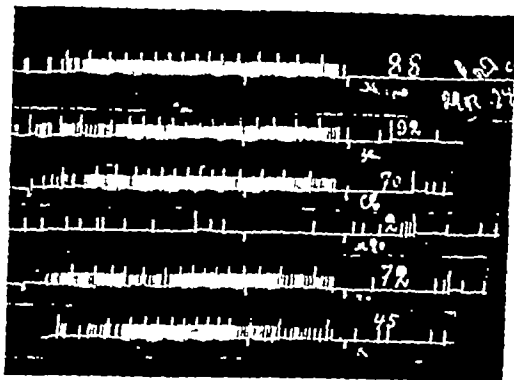


Fig 2 Diagram of salivary reflexes of a dog before exposure to light. Between the two dashes below the line the relative salivary secretion is shown, further to the left appears the absolute salivary secretion (while taking food).

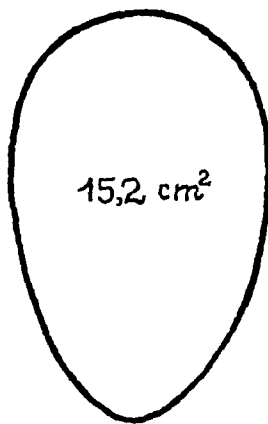


Fig 3 Radiated field on the cranium of the dog (natural size)

It has been established that the intensity of salivation depends on the strength of the stimulus: the stronger the latter, the greater the quantity of the saliva secreted in response to the conditioned reflex produced by it. Thus, it has been established in Pavlov's laboratory that, for instance, an electric bell is a somewhat stronger stimulus than the metronome, a whistle producing tone "do" is a weaker stimulus, a still weaker stimulus is light, while a tactile stimulus is the weakest. A normally activated dog responds to any one of the stimuli by a corresponding number of saliva drops in a given unit of time. The number of drops will be the greater, the stronger the stimulus. The saliva of an experimental dog is obtained through a surgical fistula on Stenson's duct or one of the parotid glands.

The experiment is carried out as follows. The dog is placed in a special sound-proof chamber (Fig 1) so that no foreign sounds shall distract its attention. A small glass bulb is fixed to the salivary fistula by means of Mendeléeff's putty, the bulb

with a graded scale. The glass tube with the scale is in the observation room outside the chamber. The drops of the liquid contained in the glass tube and consisting of electrolyte, in running out fall on metal contacts, thus forming a circuit in the registering device where every drop of saliva is registered. Figure 2 shows a sample of such automatic registration. The stimuli are set in operation either by electricity or by a pneumatic device from the observation room. The bowl containing food (meat and bread crumbs) is also placed before the dog by similar devices.

So far, I have been experimenting on three dogs. Two of them, "Rogdar" and "Rji," I received from Dr Pavlov as specimens which had been used in his laboratory for two or three years and had firmly established conditioned reflexes before I started working with them. The third dog, "Rody" (Radium), is beginning to form conditioned reflexes.

Dog No 1 (Rogdar), a mongrel, five or six years of age, of calm disposition, has a fistula on the right Stenson's duct



Fig 4 Showing epilation on the head of the dog corresponding to the radiated field

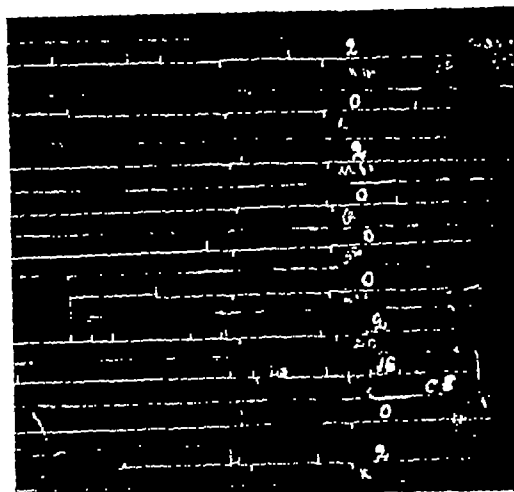


Fig 5 Diagram of salivary reflexes Nearly all the exciting factors gave negative results

The animal always eats with avidity, works with much readiness, and even jumps in the stand of his own accord. His reflexes are regular and stable. The ratio between the strength of the stimulus and the amount of saliva is permanent. Thus, on the ground of a large number of experiments it was possible to estimate the following mean figures (in drops), showing the interrelation between the stimuli and the amount of saliva

1	Bell	86	5 drops
2	Metronome at 160 beats per minute	84	
3	Tone do	65	6
4	Light	50	
5	Tactile stimulus (pricker)	36	
6	Metronome at 80 beats per minute	2	4

My first experiment with the dog was made on Dec 5, 1927. The total number of experiments performed on Rogdai up to May 8, 1928, was 103. With a few exceptions, the experiments were carried out daily.

Samples of protocols of two normal experiments preceding exposure follow.

If we take the mean figures for the period of one week following from Feb 23, i.e. for the week preceding exposure, we shall see that they are as follows

Bell	86	5
Metronome at 160 beats	84	
Tone do	65	6
Light	50	
Pricker	36	
Metronome at 80 beats	2	4
Differentiated inhibition		

In order to estimate the effect of the roentgen laboratory on conditioned reflexes, the dog was brought to the Institute of Roentgenology on Dec 28, 1927, and tied to the table, where it was subjected to a sham exposure under conditions which entirely corresponded to those of an actual exposure. Numerous further experiments have shown that such sham exposures have not the slightest effect on conditioned reflexes.

On Feb 29, 1928, at 1 P M, the dog was brought to the Institute of Roentgenology and tied to the table in the roentgen laboratory, where radiation within the region of the cerebral hemispheres was applied through a field of 15.2 sq cm (Figs 3 and 4). Technic: Neo-Intensiv with condensers, tension near the tube, 180 K V, filters 0.5 mm Zn plus 3 mm Al, giving a total of 2 H E D, or about 1,500 r.

Subsequent to radiation the dog's behavior and appetite were absolutely normal. During the week following radiation the mean values of its reflexes varied but slightly from those observed during the week which preceded exposure. The only

noteworthy; phenomenon was that the positive induction which had appeared subsequent to differentiated inhibition previous to radiation, at times was changed into negative induction in the second half of the week following radiation. By the term "induction" we mean the condition of the cerebral cortex which immediately

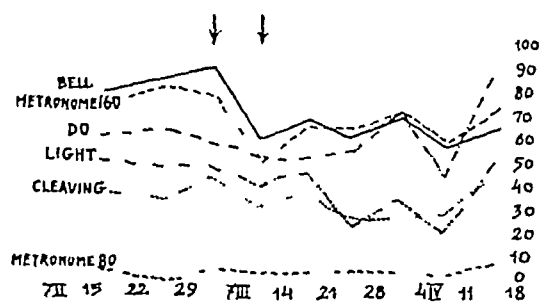


Fig 6 Curves of relative salivary reflexes with various exciting factors. Arrows indicate the radiation

follows differentiated inhibition. Induction may be positive, *i.e.*, when the condition of inhibition is followed by that of excitation, or negative, when the inhibitory condition lasts. In the first case the reflex following inhibition is considerable, in the second case, the reverse.

Thus, previous to radiation the bell sounding after inhibition produced 95 drops of saliva, the metronome, 110 drops, and the tone "do," 72 drops. After exposure to roentgen rays the bell sounding after inhibition produced 88-86 drops, the metronome, 45

After the experiment carried out on

sole difference that this time it was given a dosage of 3 H E D, *i.e.*, 2,200 r. On March 8 nothing abnormal could be observed in the dog's behavior, all conditioned reflexes were considerably decreased. On March 9 the reflexes were still further decreased. The protocol follows. On March 10 the dog was quite inert, was unwilling to jump on the stand, refused food, no borborygmus could be heard.

EXPERIMENT NO 64 MARCH 10 1928

All stimuli produced reflexes equal to zero with the exception of the light stimulus, which produced 16 drops of saliva (Fig 5).

On March 11 the dog looked quite braced up and ate and jumped on the stand with readiness. However, throughout the week following radiation the reflexes were considerably decreased.

Thus, if we compare the mean figures from March 1 to March 7, *i.e.*, for the week preceding radiation, with those observed from March 8 to March 14, *i.e.*, for the week following radiation, we shall have the following values:

Bell	91	8	62	0	70	6
Metronome at 160 beats	79	3	52	0	66	5
Tone "do"	59	8	53	7	53	4
Light	50	0	42	6	47	4
Pricker	44	7	33	5	40	0
Metronome at 80 beats	5	8	5	4	5	5

Thus a considerable decrease in all reflexes is observed which chiefly tells on such reflexes as are produced by the stronger stimuli. Besides, it is of interest to note the following very important fact:

Thus, on March 12, subsequent to differentiation, light	produced 22 drops
" " " 13 " " "	pricker " 22 "
" " " 14 " " "	bell " 75 "
" " " 15 " " "	tone "do" " 44 "
" " " 17 " " "	light " 12 "
" " " 19 " " "	tone "do" " 15 "
" " " 22 " " "	light " 24 "
" " " 23 " " "	pricker " 12 "
" " " 24 " " "	bell " 22 "

March 7, 1928, at 2 P.M., the dog was beginning with the fifth day following exposed to radiation as before, with the radiation, marked negative induction was

observed subsequent to differentiated inhibition (metronome at 80 beats)

Beginning with the fifth week following radiation, the reflexes became stronger and gradually reached their normal value toward the end of April

laboratory The total number of experiments made for my investigations with this animal was 93 During the period from Jan 26, 1928, to Feb 21, 1928, and on May 9, 1928, its brain was exposed to a dosage of 3,500 r As shown

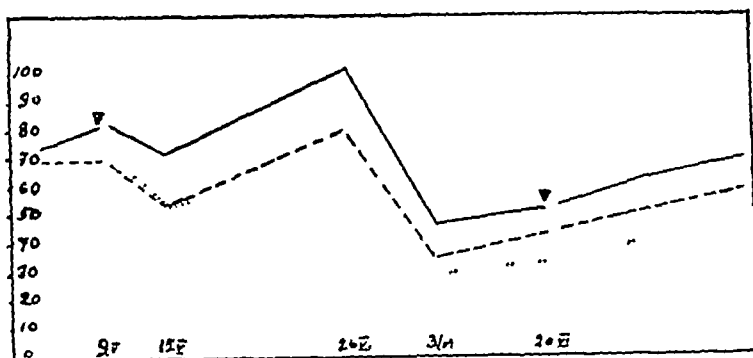


Fig 7 Curves of salivary reflexes with various exciting factors Reflexes on the strokes of a metronome are shown by the continuous line, reflexes caused by the tone "do" shown by line of dashes, by light the dotted line The black triangles indicate the application of radiation

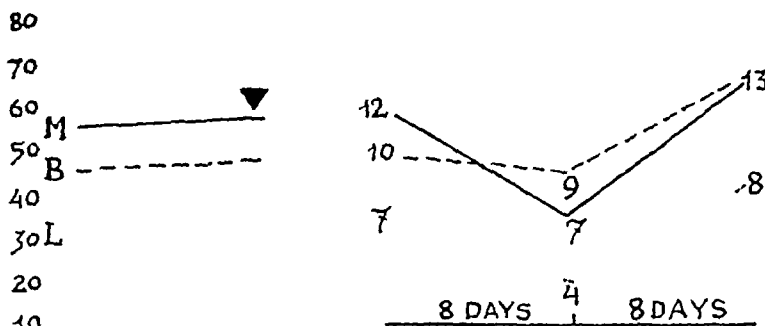


Fig 8 Curves of reflexes of the third dog (M) exciting factor (metronome in this case) (B) bell, (L) light, black triangle radiation

Previous to the third exposure the dog perished, due to an accident on May 8, 1928

In summarizing the results of experiments made on this dog we may say that radiation of the brain caused a marked decrease of its reflexes, and that this decrease was particularly manifest in the case of the stronger stimuli, *i.e.*, the bell and the metronome Besides, considerable successive inhibition (negative induction) following differentiation was observed (Fig 6)

Dog "Rij," Irish setter, adult animal, had worked for a long time in Dr Pavlov's

in the curve (Fig 7), this resulted in a marked decrease of all the reflexes in the first six days, followed by a considerable increase of reflexes in the next eleven days During the following eight days the reflexes once more decreased, thereafter remaining at these lower values It is of interest to note that the auditory stimulus tone "do" which, previous to radiation and in the first six days following it, produced fewer drops of saliva than did light, began producing more saliva than the light stimulus after the sixth day following radiation This phenomenon remained permanent until the animal's death

On June 20, 1928, the dog was exposed to secondary radiation (dosage 2,800 r) After exposure, a slight increase of reflexes was observed, which, however, remained below the values observed in the dog previ-

In the future my experiments will be carried out on a larger scale. A special laboratory for the purpose of studying, by means of the conditioned reflex method, the effect produced by roentgen rays and

EXPERIMENT NO 52, DEC 29, 1928

Time	Stimulus	Latent period (sec)	Time of delay (period elapsing between the moment when the stimulus begins acting and the time when the dog receives food) (sec)	Number of saliva drops
9 30	Tone do	3	30	65
9 38	Metronome at 160	3	30	82
9 44	Metronome at 80	3	30	0
9 50	Bell	3	30	95
9 58	Pricker	4	30	25
10 04	Light	4	30	53

EXPERIMENT NO 53, FEB 29, 1928

(The day of exposure to roentgen rays, 3 hours previous to it)

Time	Stimulus	Latent period (sec)	Time of delay (sec)	Number of saliva drops
9 31	Metronome at 160	2	30	93
9 38	Bell	3	30	92
9 47	Light	4	30	70
9 53	Metronome at 80	9	30	2
9 58	Tone do	3	30	72
10 05	Pricker	4	30	45

EXPERIMENT NO 63, MARCH 9, 1928

Time	Stimulus	Latent period (sec)	Number of drops
9 32	Bell	5	48
9 40	Pricker	3	20
9 46	Tone do	3	40
9 53	Metronome at 80 beats	9	4
9 58	Light	3	30
10 07	Tone 'do'	4	30
10 15	Pricker	5	35

ous to the first exposure, and later they again developed a tendency toward decreasing (Fig 7) On Sept 15, 1928, the dog was killed and dissected

My work has not yet been completed but, even now, I am able to say that my presumptions have been confirmed. Roentgen rays do affect the activity of the cerebral hemispheres, apparently causing an inhibitory condition

radium on the activity of the cerebral hemispheres is being equipped at the Institute. It seems to me that the application of this method is full of possibilities

The method of conditioned reflexes not only enables us to study the effect of roentgen rays and radium on nerve cells but it also helps us to solve a number of problems connected with the physiology of the cerebral hemispheres. It does not seem im-

possible that by applying rigorously limited local radiation, with radium in particular, we shall be able to localize definite centers of conditioned reflexes produced by this or the other receptive apparatus of our senses. No light has so far been thrown on this tremendously important problem.

Further, by applying the method we shall be able to study the effect of the radiation of ductless glands on the activity of the cerebral cortex. Thus, I intend to carry out investigations which help to determine by the conditioned reflex

method the effect produced by the radiation of the puberty glands on the activity of the cerebral hemispheres.

We shall also undertake the study of conditioned reflexes in children exposed to radiation for the treatment of fungous diseases of the scalp. So far, it has not been established whether or not radiation of the skull affects a child's brain. Apparently, if any changes are produced, they can be revealed only by the conditioned reflex method, as our clinical methods are much too crude for the purpose.

THE EFFECT OF ROENTGEN RAYS ON THE BRAIN

EXPERIMENTAL INVESTIGATION BY MEANS OF THE CONDITIONED REFLEX METHOD

By PROF DR M I NEMENOW, *Leningrad, U S S R.*

From the State Roentgenologic, Radiologic, and Cancer Institute, Director,
Prof Dr M I Nemenow

THE study of the effect of roentgen exposure on the activity of the cerebral hemispheres was first undertaken by me over four years ago, *i e*, in 1927

Even the first findings served to show that evidently my suppositions were confirmed. Due to roentgen exposure the conditioned reflexes in dogs after a fairly short period of time showed certain deviations from such reflexes as had been previously firmly established. These changes, as a rule, revealed a primary increase of the reflexes, followed by their more or less lasting decrease (see curves). Besides, a qualitative deviation from normal reflexes was observed. Thus, a stronger stimulus produced a weaker response as compared to that produced by a weaker stimulus, and so forth.

The important findings I then obtained enabled me, in the Summer of 1928, to make a preliminary communication at the V All-union Congress of Roentgenologists and Radiologists and at the II International Congress of Radiologists in Stockholm.

However, realizing the importance of the subject, I put off the publication of my paper until the findings reported in my preliminary communications had been confirmed by further experiments and investigations.

Later, after a suitable laboratory, with a technically perfect chamber, had been equipped at the State Institute of Roentgenology and Radiology, the investigations were carried out along several different lines. The work was carried out in collaboration with Professor P S Kupalov, A M Ushakova, and Professor R S Lyman, of the United States of America. Histologic examination of the brain was

performed in the case of some dogs in Munich by W Scholz.

Besides, studying the conditioned reflexes in adult dogs, the brains of which had been subjected to roentgen exposure, I also started to expose to roentgen rays the brains of pups in whom conditioned motor reflexes were subsequently established. When the pups became adult dogs they were provided with salivary fistulae and their salivary responses were then studied.

The peculiar conditions of a roentgen room were made familiar to the dogs at an early age, they were taught to lie motionless under the roentgen tube without being either anesthetized or fixed to the stand. This served to exclude the effect of such undesirable factors as an anesthetic or the sense of fear on the behavior of dogs.

Our further investigations fully confirmed the findings I reported in my preliminary communication. Likewise, we were able to observe a number of most interesting phenomena concerning dogs which had been subjected to radiation at an early age. Thus, we observed in radiated pups a tendency to walk in circles for several months subsequent to exposure to the roentgen rays. The dogs mostly walked in circles clockwise. They showed considerable delay both in growth and weight, as well as in mental development. With time, this backwardness was more or less overcome, depending on the dosage applied.

In dogs which had been exposed to radiation at an early age we observed epileptoid fits, occurring several weeks subsequent to exposure and sometimes recurring after a lapse of several months, the fits greatly re-

sembling genuine epilepsy in man. Obviously they were preceded by a condition of dimmed consciousness. This was followed by general convulsions and foaming at the mouth.

Further, we noticed that dogs exposed to roentgen rays either at an early age or when fully grown did not live long. Professor Kupalov and Professor Lyman, in their experiments, exposed adult dogs to heavy dosages of roentgen rays (15-20 HED), with the result that a marked decrease of reflexes was observed.

Having observed the epileptoid fits which developed in dogs after a considerable time had elapsed since exposure, and the early death of such dogs, which could hardly be accounted for by any other factor but radiation, we subjected the brain of one of the dogs to a histologic examination at Spielmeyer's laboratory in Munich. A detailed account of the findings will be reported in the near future by Professors Lyman, Kupalov, and Scholz.

The changes which were observed to occur in the cerebral tissue a considerable time subsequent to exposure threw a light on the question which, so far, had remained vague, namely, the radiosensitivity of cerebral tissue. It is well known that the majority of investigators concerned with the study of the effect of roentgen rays on the cerebral tissue, ganglion cells in particular, of adult animals have been led to believe it to be completely insensible to roentgen rays. Such statements in the literature served as a stimulus to make me approach the problem by applying the conditioned reflex method for the study of the functional changes thus produced. The method served to prove beyond doubt the occurrence of functional changes in the cerebral cortex, which appeared shortly after exposure.

Histologic examination, performed many months subsequent to the exposure of the brain to roentgen rays, revealed a further development of the process as characterized by marked microscopic changes. The negative results obtained by histologic examination and previously reported in the

literature can be accounted for by the fact that the experiments were performed too soon after exposure, while the process had not yet attained the stage of development when it could be revealed by the microscope.

Here I should like to emphasize once more the idea which was the basis of my theory with regard to the biologic effect of roentgen rays.

Molecular processes caused in living tissues by any factor develop the slower, the longer the life, or, in other words, the greater the power of differentiation, characteristic of the elements of these tissues. This probably explains why the pathologic process produced in nerve cells by roentgen rays is so slow to develop. The consideration seems to apply equally well not only to roentgen rays but to other factors as well. It obviously refers both to separate cells and to organisms as a whole.

Thus we know that by applying coal tar we are able to cause the development of cancer as early as in four months' time in a white mouse, while in a rabbit the same process takes no less than a year to develop. In the case of man being subjected to the effects of a cancerogenous factor, the latter must necessarily be at work for a number of years before it results in cancer.

Professors Lyman and Scholz have established on our experimental animals that the changes observed in the cerebral tissues were the more manifest the greater had been the period which had elapsed between exposure to roentgen rays and the death of the dog. Thus, in several months' time subsequent to exposure they observed multiple necroses of the cerebral tissues, due to the hyaline degeneration of intracerebral arteries. In the earlier stages following radiation marked symptoms of encephalitis were observed. These workers believe the changes in the cerebral vessels to be primary, and the above-described changes in the nerve tissue (necroses) to be secondary. However, it is hard to form any definite conclusion on the subject as

it is the entire brain which is exposed to roentgen rays the cerebral vessels included. The latter doubtless reveal morphologic changes at an earlier period and after lighter dosage than do the nerve cells of an adult animal. Personally I consider that the injury to nerve cells by roentgen rays may also be of a primary nature. This is confirmed by the changes which occur in conditioned reflexes soon after ex-

posure, as well as by the symptoms of encephalitis which are also observed at a relatively early stage. However, I repeat, the question has not yet been solved, for under the circumstances we have to deal with the effect of roentgen rays on the brain as on a complex of interdependent tissues. Our investigations along these lines are being continued and the results will be reported.

A NEW METHOD FOR THE RADIOGRAPHIC EXPLORATION OF THE MEDIASTINUM AND CONCEALED PORTIONS OF THE PULMONARY FIELDS

By PAUL M. ANDRUS, M.D., F.R.C.P. (C), London, Canada

From the Mara Research Laboratories at the Queen Alexandra Sanatorium¹

PART I THE CONCEALED PORTIONS OF THE PULMONARY FIELDS

SUBSTANTIAL volumes of lung tissue are eclipsed and concealed by the mediastinal structures in conventional

frequently well within the normal limits in the presence of clinical pulmonary disease, and metastases might, of course, be deposited in these concealed parts. Unexplained hemoptysis is also a rather frequent condition which might conceivably

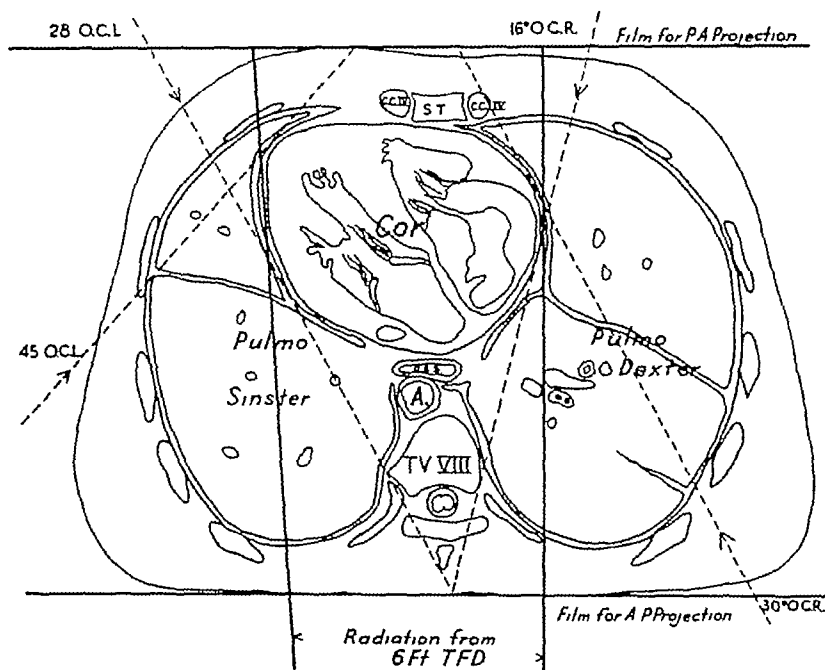


Fig 1 Cross-section of thorax at level of eighth thoracic vertebra

roentgenograms of the thorax. The frequency with which important or determinative structures lie in these hidden areas is unknown. In the press of daily routine we are prone to forget the very existence of these parts or to speculate on their inherent possibilities. That it is possible for these areas to be the seat of obscure disease must be conceded, and the finding of tubercle bacilli in the sputum of individuals in whom no parenchymatous shadows are demonstrable is not rare. The radiographic shadows are

have its origin in such hidden places. The extent of these concealed areas is shown in the accompanying tracing from Eycleshymer and Shoemaker's "A Cross-section Anatomy"² (Fig 1). The converging heavy lines indicate the path of the rays from a six-foot focus-film distance, and it is apparent that the pulmonary fields in the areas medial to these lines are not made visible by this projection. The volume of lung tissue thus concealed is large at the bases, especially the left, but becomes relatively small above the level of the bifurcation of the trachea.

¹ Assisted by the National Research Council of Canada

² Courtesy D. Appleton & Co. publishers

We accordingly attempted to radiograph these concealed portions of the lungs. The customary oblique film, for which the patient is rotated, may be used to project these areas onto the film, but has the very decided disadvantage of removing the part some distance from the photographic material. An equally important disadvantage of the oblique method for this purpose is the difficulty of measuring the angle of rotation of the subject, a measurement which it will be seen from the diagram must be possible of, at least, some approximation of control. However, if the area to be examined is placed flat against the film in the usual manner (A-P or P-A), and the tube off-centered to a suitable degree to the same side, the concealed portions of the lungs may be projected onto the film with satisfactory detail. This technic we term "off-centered exposures" and designate O C, R or L,³ (right or left), with the number of degrees, and P-A or A-P position.

1 RADIOGRAPHY OF THE LUNG MARGIN ANTERIOR TO THE RIGHT BORDER OF THE MEDIASTINUM

This area is not voluminous and does not extend above the bifurcation of the trachea. With the anterior chest wall in contact with the film, this area may be radiographed by off-centering the tube about 30 degrees to the right (Fig 1). It is to be noted that the volume of lung superimposed on the anterior margins is rather less in this off-centered projection than in tube-centered postero-anterior exposures.

2 RADIOGRAPHY OF THE LUNG MARGIN ANTERIOR TO THE LEFT BORDER OF THE MEDIASTINUM

This margin lies chiefly between the second and fourth costal cartilages. However, it is not infrequently the seat of crepitant râles in tuberculous disease as well as a focus of bronchiectatic dilations, and

its visualization may therefore be important. An off-centering to the left of 45 degrees (P-A exposure) is necessary to project this margin onto the film. The upper portions are apt to be superimposed on the shadow of the sternum and visibility thus impaired.

3 RADIOGRAPHY OF THE LUNG IN THE RIGHT PARAVERTEBRAL FOSSA

The maximum of lung tissue that it is possible to radiograph in this location is obtained by lining up the focal spot of the tube with the right border of the mediastinum and the right margin of the spine, using an antero-posterior projection. Moderate new tissue is thus revealed in the post-cardiac area and less important volumes above this level. Above the bifurcation of the trachea no significant gain is apparently made as compared with tube-centered exposures. An average off-centering of 16 degrees to the right with an antero-posterior projection is suitable for radiography of this area (Fig 1). It will be noted that a rather small volume of lung tissue adjacent to the posterior mediastinum (on both sides) cannot be visualized in this projection.

4 RADIOGRAPHY OF THE LUNG IN THE LEFT PARAVERTEBRAL FOSSA

The increase in lung tissue radiographable in this location is greater than on the right. The maximum of tissue is radiographed by lining up the focal spot of the tube with the left margin of the spine and the left border of the heart, in an antero-posterior direction. An off-centering of 25 degrees may be used as an average for this area, although the angle varies at different levels, according to the width of the heart. In radiographing the paravertebral area on either side, the angle to which the tube is off-centered must be correctly ascertained, else either the heart or the spine will be projected over the lung area it is desired to study. In the case of an enlarged or dislocated heart, the angle of off-centering would have to be

³ R and L refer to the patient in all positions

increased and the amount of new lung made visible would be lessened. The angle will also vary with different individuals. It is wise to study cross-sections of the thorax at all levels to become familiar with the projections.

5 RADIOGRAPHY OF THE MEDIAL SURFACE OF THE UPPER LOBES

Although the volume of lung tissue concealed by the mediastinum above the bifurcation of the trachea is small, it is theoretically possible for disease, such as subpleural caseous tubercles, to lie in this area. An improved visualization of the medial surfaces of the upper lobes may be possible by off-centered exposures of about ten degrees to each side.

TECHNIC

The tube position for off-centered exposures of these concealed lung areas, is tabulated for convenience (Table I).

TABLE I—TABULATION OF PROJECTION FOR OFF-CENTERED EXPOSURES

Lung area	Projection	Degree of off-centering
Right ant margin	P-A	30° R.
Lt ant margin	P-A	45° L.
Rt paravertebral area	A-P	16° R.
Lt paravertebral area	A-P	25° L.
Medial surface of upper lobes	P-A	10° R. and L.
Tracheal bifurcation	P-A	35° R. and L.

The following method may be used for placing the tube at the required angle, for trial or occasional exposures. Construct upon the floor, as with colored crayon, a perpendicular to the center of the film and at four feet from the film construct a second line at right angles. Mark off to right or left of this intersection the distance given opposite to the required angle in Table II. On the radius joining this point with the center of the film may be measured any desired target-film distance. A plumb line may be used to place the focal spot above the determined point. It is important that the long axis of the tube be placed at right angles to this

radius, *i.e.*, that the focal spot be "pointed" at the center of the film. This is especially important in the case of line focus tubes.

A much simpler and more flexible arrangement, however, when such exposures are made with any frequency, is to mount

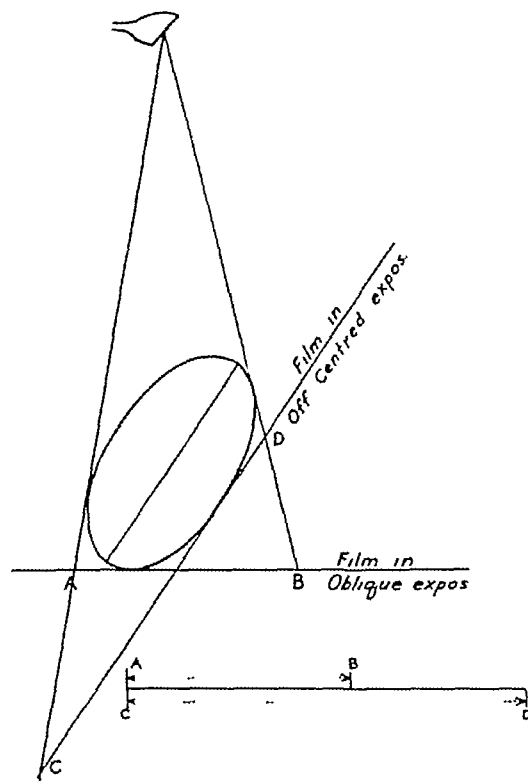


Fig. 2 Oblique view off-centered projection

TABLE II—TABLE FOR OBTAINING REQUIRED TUBE ANGLE FOR OFF-CENTERED EXPOSURES

Angle (degrees)	Off-centering (at 4 ft perpendicular distance) (in.)
10	8.5
15	12.9
20	17.5
25	22.4
30	27.7
35	33.6
40	40.3
45	48.0
50	57.2

the cassette holder on a heavy plank base and to insert a pin through this into the floor below the center point of the film. The cassette may then be rotated instead of moving the tube stand. A scale of angles should be provided. With this device a set of exposures may be made

about as quickly as are routine chest radiographs

It is important to provide a cassette holder about which the patient may wrap the arms in order to get the scapulae and muscles out of the way. The horizontal type of cassette changer is, for this reason, not well suited to off-centered exposures.

The patient should be off-centered on the cassette toward the same side as the tube, to such degree as to project the desired parts onto the center of the film. Without this precaution the areas to be examined may be projected off the film.

RESULTS AND DISCUSSION OF RADIOGRAPHY OF CONCEALED PORTIONS OF PULMONARY FIELDS

We have radiographed in this manner the concealed portions of the pulmonary fields in a number of individuals having positive sputum or frank hemoptysis but in whom no parenchymatous disease was demonstrated in tube-centered exposures, also in a number of individuals with chronic non-specific basal disease. We have not demonstrated "new" shadows in any of this group, which is, of course, no evidence that such may not occur.

In the case of acute or chronic bronchopneumonias or metastases, it is, of course, possible that they may be confined to these concealed areas, it seems probable, however, that they would as a usual thing also occur elsewhere. The method is not necessary for the visualization of lipiodol-filled spaces as these may be radiographed through the heart.

In the case of tuberculosis, it seems improbable to this author that such hidden pulmonary foci are customarily the source of tubercle bacilli in the case of those sputum-positive cases showing no parenchymatous shadows. This for the following reasons:

1 Localized pulmonary tuberculosis of limited extent and confined to a base, is unusual in the visible portions of the lung-fields, and is, therefore, probably also unusual in the smaller concealed portions

2 Primary basal tuberculosis is usually a rapidly progressive disease, whereas the outlook in sputum-positive cases without demonstrable lesions is uniformly good. The mediastinal glands are a possible source of bacilli in such cases.

PART II THE MEDIASTINUM

In the preparation of films of the concealed portions of the pulmonary fields by means of off-centered exposures as in the preceding section, there was noted a high visibility of the bifurcation of the trachea and main stem bronchi, such as is not observed in any of the conventional projections including the oblique.

In tube-centered exposures these structures are, of course, covered by the spine, while in oblique exposures the main stem bronchi are projected close together or overlapping, and their visualization is of a low order.

The mechanism of projection in off-centered exposures is shown in Figure 2. It is seen that the size of the image C D for the off-centered exposure is considerably greater than is the image A B resulting from the oblique exposure. These measurements are superimposed at the bottom of the diagram for convenience of comparison. The image is magnified in the off-centered exposure because of the angle between the film and the incident radiation. This magnification occurs in the horizontal but not in the vertical plane. It is thus apparent that the separation of the images of the main stem bronchi in off-centered exposures is the result of distortion or magnification in the horizontal plane. Such a tracheal exposure is shown in Figure 3. Associated structures, such as glands, may thus be possible of visualization in more nearly their correct relations to the trachea and main stem bronchi.

In addition, the scapula and scapular muscles can be much better removed from the fields when the patient is flat against the cassette than when he is obliquely placed. Also, as previously noted, it is most difficult to measure or duplicate an

angle of obliquity between the patient and cassette, whereas the angle between a cassette and tube is capable of measurement with any required degree of accuracy

TECHNIC

An off-centering of 35 degrees is necessary to uniformly expose the carina, although in most subjects 30 degrees is sufficient. An off-centering to the right (P-A projection) gives the most satisfactory view and displays most of the left main stem bronchus. To be sure of a full visualization, however, 35 degrees off-centered exposures from both right and left should be made.

The patient's arms should be wrapped around the cassette to remove the scapulae as much as possible from the fields. In addition, the patient should be off-centered on the cassette to the same side as the tube to such a degree as to project the posterior mediastinal contents to the center of the film. To attain this, the patient's chin should usually be placed only two or three inches from the edge of a 14-inch cassette.

Considerably greater energy is necessary than for tube-centered exposures of the pulmonary fields, and one need aim at a less high degree of contrast. The pulmonary fields are, of course, thus greatly over-exposed.

DISCUSSION AND RESULTS

Using this method, glandular masses in both adults and children are not infrequently visible which are not seen in tube-centered or the conventional oblique exposures. Their position in relation to the trachea or main stem bronchi is also apparent. Such visualization depends, of course, upon the presence of calcium, because of the density of the vascular structures with which they are contrasted. Complete calcification is not necessary, as scattered lime may indicate the presence of caseo calcareous deposits.



Fig 3 Off-centered view of tracheal bifurcation

It would seem that an improved visualization of the occurrence, extent, and relationships of the glands in the region of the tracheal bifurcation can be expected to constitute an important advance, especially in the study of tuberculous infection in children.

We present the suggestion of off-centered thoracic exposures for the radiography of the concealed portions of the pulmonary fields and the region of the tracheal bifurcation, in anticipation of a more widespread experience than is possible in a single center, determining whether the procedure has anything of importance to add to our medical methods. A further application of the method should be in the study of the mobility of the roots of the lungs, as suggested by Macklin (1).

REFERENCE

- (1) MACKLIN, CHARLES C. The Dynamic Bronchial Tree. *Am Rev Tuberc* 25, p 393

- (4) Operate the lever *P* by quick manual impulse. At the time the brass plate *Q* impinges on the rubber diaphragm, light passes through to the film momentarily. A short time later, the x-ray tube, actuated
- position, the lid is opened, and the shutter *J* is closed.
- (5) Remove the drum to the dark room and develop about four minutes in x-ray developer. A sample copy of a film

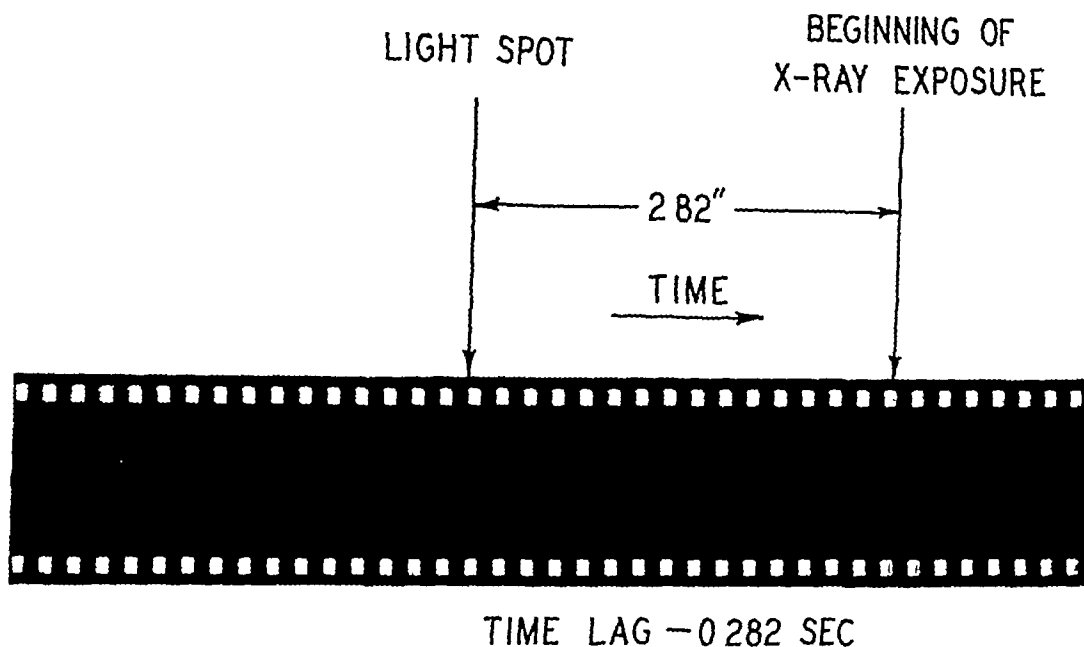


FIG 3 A sample film

by this pulse, becomes excited. The first and successive x-ray impulses are recorded on the film through the hole *II* in the form of dots. Following operation, it is necessary to turn off the current supplying the chronograph lamp. The lever *P* is then pulled back to the original

taken in this manner is shown on this page in Figure 3.

The technic which has been employed most successfully is as follows: Focal spot-film distance, 24-30 in.; x-ray tube voltage, 70-80 KVP; x-ray tube current, 100 ma; time of exposure, $\frac{1}{60}$ second or more.

CARCINOMA OF THE STOMACH¹

REPORT OF A CASE TREATED BY ROENTGEN THERAPY

By JOSEPH FRIEDMANN, M.D., New York

My object in reporting this case of carcinoma of the stomach is not so much that I wish to present anything particularly different from other x-ray findings but that my pre-operative diagnosis was that of a benign tumor or papilloma.

This case was referred by Dr. A. J. Walscheid

for roentgenographic examination Feb. 14, 1927. Roentgenoscopic examination of stomach after a barium suspension meal shows that the stomach is situated to left of median line, greater curvature is even, and is 4.5 inches below the umbilicus. On palpation near the pylorus, a distinct mass about 1.5 inches in size, not movable, is felt between the palmar surfaces of the fingers.

Films taken in the upright, prone, and in the right lateral view, show that near the antrum of the stomach there is a faint irregular rarefaction, $\frac{1}{2} \times \frac{7}{8}$ inch in size. The first portion of duodenum is somewhat irregular. Examination, six hours after the barium suspension meal, shows a faint residue in the stomach. Rest of gastro-intestinal tract is negative.

¹ Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City Nov. 28-Dec. 1, 1932.



Fig 1 Showing a faint irregular rarefaction near antrum of stomach $\frac{2}{3} \times \frac{1}{8}$ inch in size first portion of duodenum irregular (Feb 14, 1927)

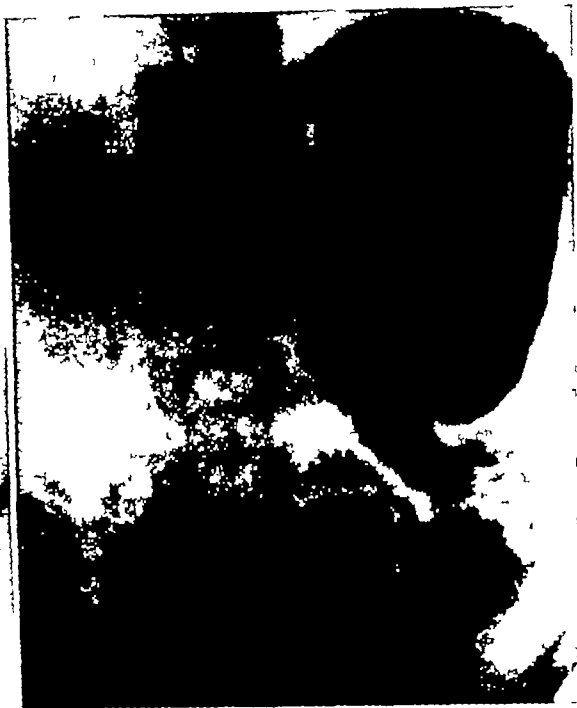


Fig 2 Showing gastro-enterostomy opening which functions normally (Dec 31, 1928)

History—Seven months ago, J P, aged 43 years, began to have discomfort about one hour after meals, frequently vomiting his entire meal. He has lost from 13 to 20 pounds in weight, at times he gains only to lose again.

Operation was performed March 10, 1927. A subtotal gastrectomy, Balfour method, jejunal-jejunostomy was performed.

Report from Pathological Laboratory—The specimen is composed of a portion of tissue removed from the pyloric extremity of the stomach. There is an ulcerated area, $3\frac{1}{2}$ cm in diameter at the lesser curvature. This lesion presents a definite circumscribed margin with crater-like edges. Section shows that the lesion is confined to the mucosa and does not infiltrate the submucosa.

Microscopic examination has been made of sections through the edge of the ulcerated area of the pylorus, and also at the base. Examination of the structure at the edge shows that a portion of the surface is covered with mucosa and its glands, but the submucosa has been replaced by a tumor process which is characterized by atypical columnar epithelial cells with an alveolar arrangement. These cells vary in size and shape and they contain a vesicular nucleus, an occasional mitotic figure is observed. The stroma is scanty, and is densely infiltrated with round inflammatory cells and

polynuclear leukocytes. In areas in which the mucosa is not observed, there is some necrosis on the surface. Microscopic examination of sections at the base shows complete absence of the mucosa and muscularis mucosa. The submucosa is completely replaced by a tumor process characterized by various sized groups of atypical epithelial tumor cells in a cellular connective tissue stroma. This process has infiltrated the muscle coats but does not extend entirely through them.

Diagnosis—On March 13, 1927, the diagnosis was carcinoma of the stomach. The patient was referred to me again on April 26, 1927, for a series of deep roentgen treatments. To the radiologist, this case is interesting because of deep roentgen therapy following a gastrectomy. Very little therapy for this ailment has been used in America.

When one observes the wonderful results which were obtained in this case, and in view of the microscopic diagnosis, and the immediate and late operative results, I feel that we should give some credit to deep roentgen therapy. I have always had great confidence in the use of this post-operative mode of treatment for carcinoma of the stomach. This case was perfectly well for four years, and free from all stomach symptoms of any kind, thereby firmly establishing my confidence in the application

of deep roentgen therapy in all cases of post-operative carcinoma of the stomach Holfelder's technic was used

method for eight and one-half years, and has prolonged life in 50 per cent of his cases one year



Fig 3 Specimen removed at operation

The roentgenologist should always witness the operation to acquaint himself with the extent of the lesion, the amount of glandular involvement along the lesser and greater curvature, lig gastricum, etc., as well as other metastasis. In fact, he must mentally visualize the entire pathology, thereby enabling him to apply the rays at the proper angle. It should always be remembered that care must be taken not to radiate the kidneys, suprarenals, pancreas, spleen, and lungs, to avoid any anatomical damage, and subsequent physiological dysfunction.

The patient receives a dosage of 110 per cent, the lungs receive less than 10 per cent of this dose. The entire treatment is completed in a period of from five to seven days or longer, depending on the physical condition of the patient. For the treatment, use 200,000 volts, 4 ma of current, 0.5 mm Cu + 1 mm Al. Firm compression is used. The stomach is treated from three fields: one anterior, from right to left outward and upward, one lateral field on left side going straight through inward, and the third field posteriorly from right to left upward and outward. Holfelder has used this



Fig 4 Photomicrograph of tissue removed

From seven to ten days after the final roentgen treatment, the saturation method is given, completed in two or three days. The saturation method, as described by Dr Pfahler, indicates the greatest amount of radiation that can be tolerated by the surrounding normal tissues without damage being done to them. The saturation method depends upon the delivery into the diseased area of what we have learned to term "erythema dose" or "toleration dose," and then the retention of this effect for a certain time by additional smaller doses of radiations at intervals to correspond to the loss in effect during any period. The rate of loss, and the amount of radiation to be given at any interval, is indicated by a series of curves.

On Dec 31, 1928, a re-examination of patient's stomach, after a barium suspension meal, shows that it is situated to the left of the median line, that greater and lesser curvatures are even in contour, and that the gastroenterostomy opening is functioning normally.

Twenty months after the operation, the patient weighs 135 pounds. He eats of everything, has no complaints, no pain, his bowels are normal, and there is no eructation after eating. Before operation, he weighed 119 pounds which has increased to 148 pounds, in May, 1929.

CONCLUSIONS

- 1 Tentative pre-operative diagnosis
- 2 Laboratory tissue report on specimen resected at operation

3 Technic of roentgen therapy

4 Roentgen findings 1 year after deep roentgen therapy

Röntgentherapie der sogenannten inoperablen Tumoren erwarten? *Strahlentherapie*, 1929, 33, 131-138

2 SCHOLZ, THOMAS Application of Roentgen Radiation to the Barium-filled Stomach a Contribu-

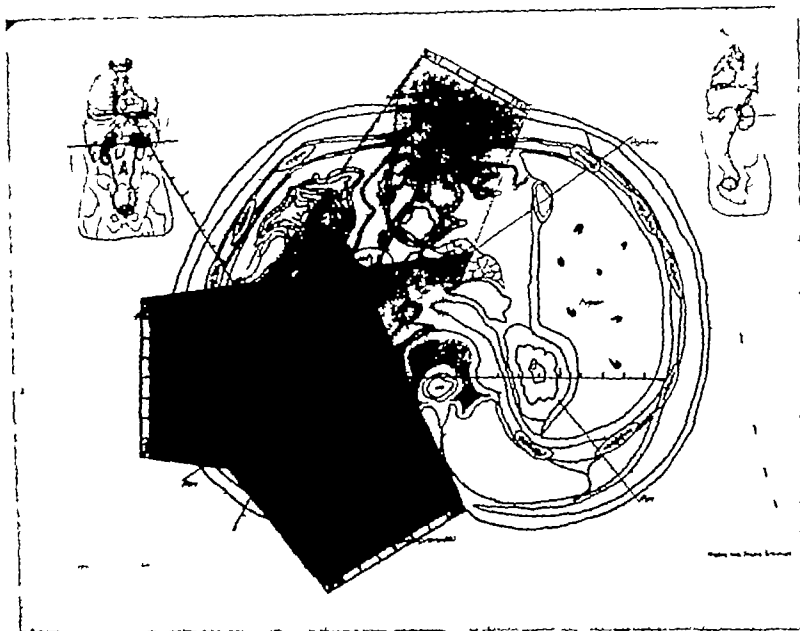


Fig 5 Here is shown the field selectors arranged in three fields across the section of stomach as suggested by Holfelder

5 Patient under observation April 15, 1931, and feels perfectly well

6 Patient died from carcinoma of the liver, May, 1932

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PELVIMETRY BY MEANS OF STEREOSCOPIC X-RAY PLATES¹

B. DOSTER BUCKNER, M D, Fort Wayne Indiana

For some time I have been interested in simplified pelvimetry which could be done in any x-ray laboratory possessing, in addition to the usual roentgenographic equipment, a common yardstick and a plumb bob

The method which I wish to report has nothing to do with formulae or apparatus. A knowledge of geometry is a necessity, and when the underlying principles are understood, the desired diameters are easily, quickly, and accurately made. The only possibility of error is in inaccurately marking the points on

the films from which measurements are to be made

Distortion of anatomic parts has always been a bugbear to radiologists and also to those who view x-ray plates. I have always maintained that the x-ray apparatus is a machine of precision and that, if radiographs were properly made, correct interpretation could be made. So, in attempting this problem, I have tried to prove that we should not be skeptical of x-ray films, but should keep in mind that the negative is an exact duplication of what was directly before the film at the time of exposure.

I give this method as absolutely original. I have found no literature that suggests a simple method of constructing graphically the measurements of the pelvis. Therefore, the problem to be solved is to represent graphically the exact measurement or distance between

¹ For their collaboration in this article I wish to thank Mr. A. W. Zimmerman, pioneer radiologic instructor, Miss Mildred Whitmer, mathematician, and Mr. Lillian Gerard, draftsman.

two points in the body through the use of radiographs by a simple method

Stereoscopic plates (using a Bucky dia-

Now, draw two lines from each plumb bob to the respective images that were made when the target was perpendicular to that plumb bob

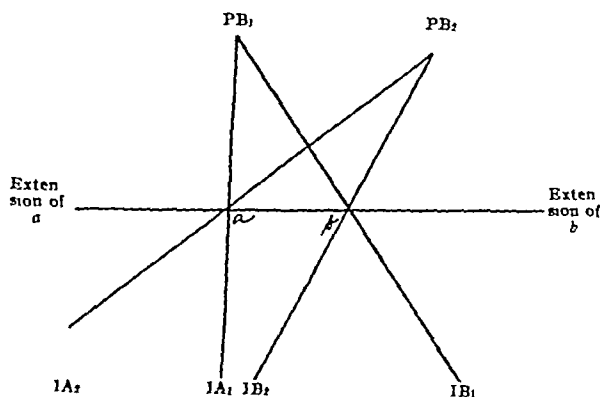


Fig 1 The two plumb bob shadows are PB_1 and PB_2 . The drawing shows the two images of a and b when in two positions, respectively at IA_1 , IB_1 , and IA_2 , IB_2 . It also shows the base lines of four right angle triangles which intersect at a and b .

phragm to make more distinct the points to be measured) are made of the pelvis, using a horizontal shift of 4 inches. The known distance from the target to the film has been set at 30 inches. A plumb-bob is attached to the center of the filter and the length of the cord allows the bob to hang just above the patient. Markers are placed on each end of the cassette carriers to show that each film is exactly in the same position.

After the films are dried, put a pin hole through each point on each film, including the plumb-bob shadows, from which distances are to be measured. Superimpose the films by means of the markers. Then fasten the films either by means of clamps, adhesive, or mucilage, or in any way that will keep them from slipping. Then repunch all holes through both films. By doing this, the pin goes through the old holes and makes a new spot on the other film. The films may either be kept together and measurements made, or separated. Place one of the films on a piece of white paper, hold firmly, and by means of a pen or pencil put dots through the holes on to the paper. After the desired points have been marked, you will have six dots for each diameter. Two of the dots represent the shadows of the plumb-bob in the two positions, and the other four dots represent both ends of the desired distance to be measured in the two positions of the target.

Of course, you will recognize that the plumb-bob shadows are the perpendicular projections of the target in its two positions. The distance between the two plumb-bob shadows represents the distance of the shift.

These lines, four in number, are the perpendicular projections of the hypotenuses of four right-angle triangles. The perpendicular sides of all these triangles are 30 inches in height, and we also know that the planes of these triangles are perpendicular to the plane in which the film was placed when exposure was made.

After the four lines are drawn (Fig 1), it will be noted that the lines cross at points a and b . A line drawn from a to b represents the perpendicular projections of the desired diameter to be measured. A continuation of line ab is used as a base line to compute final calculation.

After we have the six points and the four lines drawn, and the line ab with its extensions, the diagram is transferred to a paper a few inches longer than the distance of the target from the film. In this case the target was 30 inches, so that the paper would need to be about 6 inches longer. The line ab is placed parallel with, and as near as possible to, the lower edge of the paper, allowing the image projections to be shown.

Study of Figure 1 shows a few obvious conclusions. Points PB_1 and PB_2 are the perpendicular projections of the target on the film. PB_1 and IA_1 is one side of the right-angle triangle, the plane of which is perpendicular to the plane of the film. Likewise, the four lines of the right-angle triangles are the perpendicular projections of the hypotenuses of those respective triangles. The points a and b are the projected points from which measurements are to be taken. Line ab is the perpendicular projection of the desired distance to be measured.

We also observe that we have two pairs of triangles, paired in that their planes intersect. Using one pair of triangles and allowing one

before the Pacific Coast Roentgen ray Society, San Francisco, Dec 10, 1920

(2) COLLISI HARRISON SMITH The Value of X-ray in Obstetrics Jour Michigan St Med Soc, April, 1929, 28, 288-297

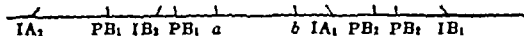


Fig 2 The base lines of the triangles are shown superimposing on base line *ab* after the pivoting of the base lines of the triangles using *a* and *b* as centers of an arc

triangle to swing clockwise and the other counterclockwise, using *a* or *b* as a pivot, we have their bases superimposing on base line *ab*. Likewise, the other pair of triangles is swung to the base line, and, using *a* or *b* as a pivot, we have a figure such as is illustrated in Figure 2

Using the base line *ab*, designated as *PB1*, *PB1*, *PB2*, *PB2*, respectively, construct the perpendiculars 30 inches in height, or the normal distance of the target from the film. From these points draw lines to points *IA1*, *IB1*, *IA2*, *IB2*, respectively. It is understood that these last lines are the hypotenuses of their respective right-angle triangles (Fig 3). A line drawn from the intersection of one pair of hypotenuses to the intersection of the other pair of hypotenuses is the distance to be measured.

This method is applicable to any desired measurement to be made. It is also helpful in localizing foreign bodies. The localization of any foreign body, the specific gravity of which is more than water, can be determined through radiographs by this method.

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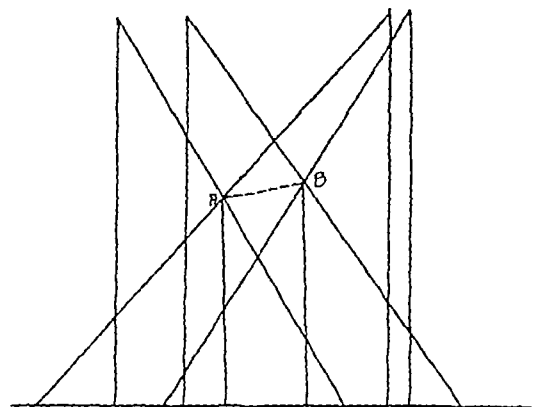


Fig 3 Reconstruction of the four right-angle triangle's actual size on the plane of the film. The intersection of the two pairs of hypotenuses are the points from which measurements are to be taken.

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CHOLECYSTOGRAPHIC STUDY OF THE BILE DUCTS¹

REPORT OF AN UNUSUAL CASE

B. HAROLD SWANBERG, M.D., F.A.C.P.
Quincy, Illinois

Cholecystographic examinations of a normal human being show the gall-bladder outline, frequently the cystic duct, and occasionally the common bile duct. I wish to present a case in which the roentgenograms show the entire biliary system, with the exception of the bile capillaries. In order to refresh the reader's

memory concerning the biliary system, the anatomic study is briefly reviewed.

BILIARY TRACT ANATOMY

The liver consists of two main lobes, the right and the left, each composed of small individual parts called lobules which are held together by extremely fine areolar tissue. The size of the lobules are from 1 to 2.5 mm in diameter, and each lobule consists of a mass of cells called the hepatic cells which secrete the bile.

The biliary ducts, which convey the bile, originate in the little passages in the liver cells which communicate with canaliculi, termed bile capillaries or inter-cellular biliary passages. These passages are merely small chan-

¹ Read before the Section of Radiology of the American Medical Association at Milwaukee Wis. session June 15 1933

nels or spaces left between the contiguous surface of two cells or in the angle in which three or more liver cells meet. The channels thus

brane lining its interior is thrown into a series of from five to twelve crescentic folds, similar to those found in the neck of the gall bladder,

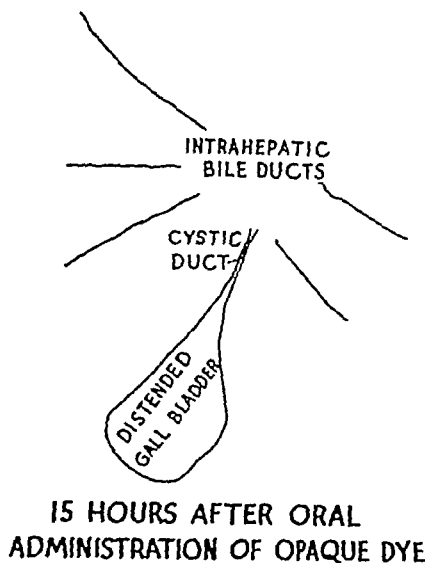


Fig 1 Outline tracing of Figure 4

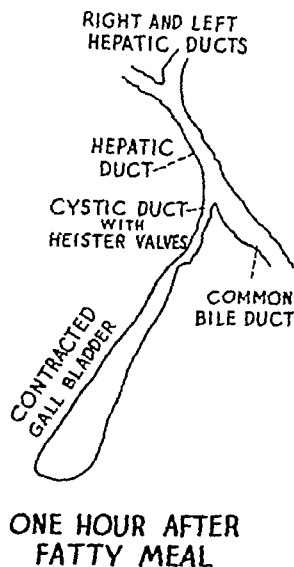


Fig 2 Outline tracing of Figure 5

formed radiate to the circumference of the lobule and open into the interlobular bile ducts which accompany the portal vein and the hepatic artery. These join like the twigs and branches of a tree to eventually form two large main biliary ducts, the right and left hepatic ducts,² nearly of equal size, and which issue from the liver at the porta hepatis, one from the right, the other from the left lobe.³ These unite to form the hepatic duct, which passes downward and to the right, for three or four centimeters, where it is joined at an acute angle by the cystic duct from the gall bladder and forms the common bile duct. The common bile duct is about seven centimeters long and normally about three millimeters in diameter. At the termination, it unites with the pancreatic duct and opens by a common orifice upon the summit of the duodenal papilla, situated on the medial side of the descending portion of the duodenum. The short tube, formed by the union of the two ducts, is dilated into the ampulla of Vater. The cystic duct, about three to four centimeters long, runs backward and to the left from the neck of the gall bladder to join the hepatic duct. The mucous mem-

which project into the duct in regular succession. These resemble in appearance a continuous spiral valve and are called the valves of Heister.

SHERWOOD MOORE'S COMMENTS

Recently, following the oral administration of opaque dye to a patient, the entire biliary duct system was visualized with the exception of the bile capillaries. This observation appeared so unusual that the findings were communicated to Dr. Sherwood Moore, radiologic co-worker of Dr. Graham and Dr. Cole, discoverers of cholecystography. In a personal communication Moore stated:

In reply, I would say that we have not visualized the ducts of the biliary tract in the course of a cholecystographic examination. We feel that by so doing the ducts would not have sufficient concentration of cholecystographic dyes to be made visible. Accounts of this have appeared in the literature from time to time but these have not been convincing and none of them have been accompanied by illustrations or at any rate illustrations that were plain enough to have left any impression upon my mind. We have always felt that visualization of the gall bladder is due to concentration of dye and that the dye in the bile ducts was too diluted to be visualized. As a corollary to this we have considered that concentration occurred only in the gall bladder though I believe the reason that the dye is visualized in the large intestines as it is occasionally is due to the fact that that structure takes up water and concentrates its contents. There is a well established contention that in the absence of function of gall bladder either through removal or

² The right and left hepatic ducts particularly the latter are formed by the junction of the several smaller ducts.

³ The bile from the caudate and Spiegelian lobes enters the left hepatic duct.

disease the ducts take on some, if not all, of its functions, among them being that of concentration of bile and hence concentration of cholecystographic dyes. In deference to such views we would consider that there

opaque dye, was negative. Fifteen hours later, the gall bladder was distinctly visualized, being normal in position, size, shape, and of uniform

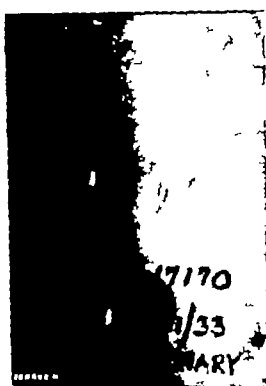


Fig 3 Preliminary roentgen examination of the gall-bladder area, before the oral administration of dye for cholecystography. The findings were negative.



Fig 4 One of the two roentgenograms made of the gall-bladder area 15 hours after the oral administration of dye.



Fig 5 One of the two roentgenograms made of the gall-bladder area one hour after taking a fatty meal, and 18 hours after the oral administration of the dye.

might be given the necessary conditions a possibility of visualizing the ductal system of the biliary tract.

I would say having recently reviewed the literature that you have a very valuable observation and I would urge you to report it. This I believe, constitutes an important finding on the question of the ability of the duct portion of the biliary tract to concentrate the bile and is, therefore, an important point both in the physiology of the biliary tract and its compensating function and has an important bearing on cholecystography.

In accordance with Moore's suggestion the following case is briefly reported.

CASE REPORT

Mrs F K, aged 42 years, weight 117 pounds, suffering from dyspepsia, and on whom a thyroidectomy for hyperthyroidism had been performed some years ago, was referred by Dr O F Shulian, of Quincy, Illinois, for roentgenologic study on Jan 21, 1933. Among the examinations made was a cholecystographic study, a powder mixture of tetraiodophenolphthalein sodium salt in aqueous solution being given orally (immediately after a full meal, free from fats), in accordance with our usual technic. A preliminary examination of the gall bladder area, before administration of the

density. There were a number of opaque linear shadows, radiating like the spokes of a wheel, from the region of the under surface of the liver, corresponding to the porta, which we have interpreted as being some of the dye-filled intrahepatic bile ducts. These were constant in the two roentgenograms made at that time. Two hours later, and following a fatty meal, the intrahepatic bile ducts were no longer visible (a few very fine linear shadows remained), but the two large main biliary ducts were seen joining together to form the hepatic duct, this latter duct being clearly visualized. The gall bladder was now seen to be distinctly contracted, the cystic duct being visualized but somewhat irregular in contour because of the presence of the Heister valves. The union of the cystic and hepatic ducts was clearly outlined, forming the common bile duct, which could be traced for several centimeters. After the fatty meal, the findings were present in both roentgenograms taken at that time.

This examination was reported to be "a normal cholecystographic response," the unusual feature of the case being the visualization of nearly every part of the biliary tract by the oral administration of the opaque dye.

EDITORIAL

LEON J MENVILLE, M D , *Editor*

HOWARD P DOUB, M.D , *Associate Editor*

WE MUST JOIN HANDS

We are witnessing to-day in America the spectacle of armed violence running riot through the land. This modern Robin Hood, many times more vicious than any previous one, threatens the very foundations of society. To meet it local forces has proved in vain, units of various kinds are ineffective. Not until there is concerted action, a unification of purpose, and a complete sacrifice of individualism in the interest of the whole, shall we see an end of such disastrous things.

Imagine, for a moment, an army fighting some national peril. Men are trained in the North, others in the South, East, and West. Some are prepared for land and others for sea fighting, some for the air, and others for trench work. But there comes a time when all must join hands, and under some central guidance work toward a prescribed goal. Should any unit or section refuse to obey orders, and selfishly decide upon separate action, we would see that its work would for the most part be lost and rendered ineffectual. The lack of concerted action would result in a loss to the entire nation, and present a stumbling block to the ultimate goal.

There is a time in the history of all movements when union becomes necessary, if we would attain the best results. The life of the infant is lived within a very circumscribed area—and rightly so. There, in it, it may be protected, and encouraged, so that it may grow and finally reach maturity, and along with other infants it presently arrives at the stage when it may well emerge from its sheltered existence, and join the life of the larger group, and so make its fullest contribution to the life of the world. Its treasured individualism must be prepared to offer itself on the altar of society, to test its intrinsic values in a measure determined not only by its unique contribution, but in the way that it can be adapted for the good of the group as a whole—as part of something greater than itself. Men and their ideas, when clearly crystallized, must be ready to lose themselves in some central and controlling viewpoint, to be really effective.

Isolated, they are utterly limited, but in concert with others they become triumphant.

It is with these thoughts in view that I consider our own branch of medicine. Our radiological societies have each had a unique place in the building up of our special work. To those pioneers who have never spared themselves in this cause, and in the making of our work what it is to-day, we shall be eternally grateful. But it is of the future that we must think, for this generation will pass on. How best can we secure and treasure for those ahead of us all that has been gained, and how can we organize most efficiently to attain the greatest good?

Let us join hands

W HERBERT MCGUFFIN, M D

ANNOUNCEMENTS

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ADVISERS G E Pfahler, M D , B H Orndoff, M D , A U Desjardins, M D

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THERAPY A Soiland, M D

PHYSICS Lauriston Taylor

CLINICS J T Farrell, Jr , M D

SCIENTIFIC EXHIBITS COMMITTEE P F Titterington, M D , *Chairman*, R A Arens, M D , B R Kirkin, M D

THE ANNUAL MEETING

SCIENTIFIC EXHIBITS

Progress has been made in preparation for the Scientific Exhibits display at the Twentieth Annual Meeting of the Radiological Society.

of North America Every effort is being made to assure complete success The spacious, well appointed, and adequately lighted Italian Room at the Hotel Peabody, opening onto the mezzanine and convention floor, has been reserved for this purpose The adjoining Florentine Room will be used by the Committee on Scientific Exhibits

We are looking forward to having a number of interesting and instructive exhibits this year Since our president, Dr W H Mc Guffin, has conceived a rather intriguing and unique form of program, which includes clinics, it is to be expected that all members presenting clinics will have exhibits illustrating their respective subjects All of the exhibits will be classified anatomically, and so arranged on the floor, with large placards indicating their positions This procedure will facilitate ready location of those exhibits in which a member may be especially interested

We solicit your co-operation in making this feature of our program a success by applying for space in the Scientific Exhibits to show interesting cases you may have in your files

W W ROBINSON, M D,
*Local Chairman,
Committee on Scientific Exhibits*

AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will hold its Nineteenth Annual Clinical Session in Philadelphia, April 29-May 3, 1935

Announcement of these dates is made particularly with a view not only of apprising physicians generally of the meeting, but also to prevent conflicting dates with other societies that are now arranging their 1935 meetings

Dr Jonathan C Meakins, of Montreal, Que., is President of the American College of Physicians, and will arrange the Program of General Sessions Dr Alfred Stengel, Vice-president in Charge of Medical Affairs of the University of Pennsylvania, has been appointed General Chairman of local arrangements, and will be in charge of the Program of Clinics Mr E R Loveland, Executive Secretary, 133-135 S 36th Street, Philadelphia, Pa., is in charge of general and business arrangements and may be addressed concerning any feature of the forthcoming Session

EDITORIAL NOTICE

With the beginning of this, the twenty-third, volume of RADIOLOGY, plain Arabic figures are to be used in place of Roman numerals, as heretofore This is done after a survey of the practice followed by other journals, and after consulting the preferences of excellent authorities It is expected that it will further contribute to the usefulness of our Journal for its readers



Courtesy of the Journal of Chemical Education
The Late Mme Curie

of the Nobel science prizes Perhaps the greatest tribute paid Madame Curie was by the women of the United States who presented her on the occasion of her visits to this country with a considerable amount of radium, purchased for her use

LAY EDUCATION

Radiological diagnosis and treatment admirably lend themselves to publicity and when this is done it most naturally must be in accord with medical ethics and good taste Statements of fact, at no time prejudicial to the interest of any other specialty, and emphasizing that much investment in apparatus and education is necessary to proper functioning, will inculcate in the minds of the public

points vital to radiologists. So educated, the public can accept, with sensible reconciliation, the exact status of the financial as well as the medical responsibility of the physician.

A notable effort along this line was made recently in Chicago in which members of the Chicago Roentgen Society were designated to co-operate with the Chicago Lighting Institute. The latter society sponsored a two weeks meeting dealing with various forms of light as it applies to illumination and irradiation of ~~many~~ many times more vicious than any previous one, threatens the very foundations of society. To meet it local forces has proved in vain, units of various kinds are ineffective. Not until there is concerted action, a unification of purpose, and a complete sacrifice of individualism in the interest of the whole, shall we see an end of such disastrous things.

Imagine, for a moment, an army fighting some national peril. Men are trained in the North, others in the South, East, and West. Some are prepared for land and others for sea fighting, some for the air, and others for trench work. But there comes a time when all must join hands, and under some central guidance work toward a prescribed goal. Should any unit or section refuse to obey orders, and selfishly decide upon separate action, we would see that its work would for the most part be lost and rendered ineffectual. The lack of concerted action would result in a loss to the entire nation, and present a stumbling block to the ultimate goal.

There is a time in the history of all movements when union becomes necessary, if we would attain the best results. The life of the infant is lived within a very circumscribed area—and rightly so. There, in it, it may be protected, and encouraged, so that it may grow and finally reach maturity, and along with other infants it presently arrives at the stage when it may well emerge from its sheltered existence, and join the life of the larger world, and that in the future the number should be reduced. It happened that the speaker himself had an interesting exhibit, which was illustrated by x-ray films. It would be a sad mistake to curtail the x-ray exhibit—the Scientific Exhibit would be the loser. When we realize that the x-ray is used in diagnosis and therapy in every branch of medicine, it is no wonder that it has attained a prominent place in the Scientific Exhibit.

At the first examination given by the American Board of Radiology on June 10, 11, and 12,

172 applicants were examined. A majority of these applicants were pioneers in radiology and many of them made the trip for the sole purpose of appearing before the Board in order to secure certificates. This response was most gratifying as it gave evidence of support by those men who have contributed so much to the speciality. A list of those who were granted certificates will be published shortly.

There are still approximately 150 applications from men who have not yet presented themselves for examination. Further examinations will be conducted in Pittsburgh on Sept. 22, 23, and 24, and in Memphis on Dec. 1, 2, and 3. It is urged that those who wish to come before the Board at Pittsburgh have their applications on file prior to August 1, and that those who desire examination at the session in Memphis forward their applications not later than September 1.

The Section on Radiology of the American Medical Association was well represented. Most interesting and educational papers were presented and discussed by America's foremost radiologists. All of the latest and most progressive thoughts in radiology were presented.

Three Resolutions of interest were introduced by Albert Soiland, M.D., and George M. Fisher, M.D., respectively. Dr. Soiland introduced the "Resolution Authorizing Section on Radiology to Invite Fifth International Congress of Radiology to be Held in America" and "Resolutions on Exploitation of Roentgenologists in Hospitals," while Dr. Fisher introduced the "Resolution Barring from the Practice of Radiology All Persons not Licensed to Practise Medicine."

The Fourth Conference of the American College of Radiology was presided over by H. K. Pancoast, M.D., the President. The guest speaker of the Conference was Ross V. Patterson, M.D., of Philadelphia, who is Dean of the Jefferson Medical College and President of the Association of American Medical Colleges. Fellows of the College who addressed the Conference were B. R. Kirklin, M.D., Secretary of the American Board of Radiology, W. Edward Chamberlain, M.D., of the Commission on Radiological Education, Arthur C. Christie, M.D., of the Commission on Medical Economics, James T. Case, M.D., of the Commission on Public Instruction. The topic, "The Feasibility of Uniting the Scientific Organizations," was discussed during the Conference by the following: W. Herbert McGuff-

fin, M D , President of the Radiological Society of North America, John T Murphy, M D , President of the American Roentgen Ray Society, and Rollin H Stevens, M D , President of the American Radium Society

B H Nichols, M D , of Cleveland, Ohio, was the most capable Director of the local arrangements

MADAME CURIE

With inexpressible sorrow the world has just learned of the death of Madame Curie Her loss to mankind will be keenly felt, for who else has been its greatest benefactor?

The radiological professions of all nations bow their heads in sorrow and respect to the memory of this noble woman, and with heavy hearts they mourn the passing of the greatest woman scientist the world has ever known They will be consoled in the belief that she has joined the noble army of martyrs

Madame Curie, as the world knows, was the discoverer of radium some thirty years ago She was assisted in this work by her husband, Pierre Curie

This epical discovery made Madame Curie the greatest woman scientist of this or any other era We can recall but one other woman who approached Madame Curie in the field of science, and this was Caroline Leucetia Herschel, the astronomer

Madame Curie was rewarded nobly for her

wonderful discovery, not alone by her native Poland, but by all countries of the world Among the many outstanding prizes which she won was the La Caze prize, the Albert and Davy medals She was also twice the recipient



Courtesy of the Journal of Chemical Education

The Late Mme Curie

of the Nobel science prizes Perhaps the greatest tribute paid Madame Curie was by the women of the United States who presented her on the occasion of her visits to this country with a considerable amount of radium, purchased for her use

ABSTRACTS OF CURRENT LITERATURE

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APOPHYSITIS

Painful Heels Among Children (Apophysitis)
Henry W. Meyerding and Walter G. Stuck. *Jour Am Med Assn*, May 19, 1934 102, 1658-1660

Beginning with Osgood's report in 1903, an important group of syndromes accompanied by certain definite symptoms and by similar epiphyseal changes observed roentgenographically, have been described and elevated to the dignity of specific diseases. It has gradually become apparent that there are marked similarities in the general pattern of these diseases, for they all seem to follow trauma of one kind or another, occur generally in growing children, affect ununited epiphyses and are very often accompanied by such characteristic roentgenographic evidence of changes in epiphyses as rarefaction, fragmentation, and, later on abnormal calcification.

A seemingly uncommon type of this epiphyseal involvement is apophysitis of the heel or the so-called calcaneal apophysitis that is evidenced by painful heels and a limp among young rapidly growing boys. To date 40 of these cases have been reported. The heel is unique in being subject both to direct and to indirect trauma. In the Mayo Clinic 22 cases have been seen. The average age of onset was 10.2 years, the ages ranged from 7.5 to 17 years. The treatment of this condition is palliative.

C. G. SUTHERLAND, M.D.

ARTHRITIS

Roentgen Therapy of Arthritis Carl Fried. *Strahlentherapie* 1934, 49, 634-675

The literature concerning roentgen therapy in the various types of arthritis is critically reviewed by the author who also reports cases of his own. In infectious arthritis particularly of gonococcal origin the results are often very striking (120 r is sufficient over the involved joint, a dose which should be repeated if necessary after 8 days). In gout doses of from 140 to 180 r sometimes alleviate pain. The roentgen treatment of arthritis deformans is discussed at length. From 120 to 180 r heavily filtered radiation at intervals of from 3 days to 3 weeks is used by the majority of radiologists. The author first applies from 140 to 150 r, and then reduces the doses if an improvement is noted. Small joints receive less. The interval between treatments varies from 2 to 6 weeks. The mechanism of the effect of roentgen rays on the diseased joints is briefly discussed.

ERNST A. POHLE, M.D., Ph.D.

BIOLOGIC EFFECTS

Temperature and Biological Effect of Alpha Rays
F. Hercik. *Strahlentherapie* 1934 49, 703-706

The author exposed cultures of bacteria to alpha rays emitted by polonium at temperatures of 2.5, 3.5,

10, 23, 26, 35, and 36 degrees centigrade. The injury curves did not show any marked variation, and it seemed that the biologic effect of alpha rays was independent of the temperature in the cultures.

ERNST A. POHLE, M.D., Ph.D.

BONE DISEASES (DIAGNOSIS)

Suppurations of the Petrous Tip Edmund P. Fowler. *Jour Am Med Assn*, May 19, 1934 102, 1651-1655

Suppurations of the temporal bone other than those in the middle ear, mastoid and zygoma have been recognized more and more since 1904. Unilateral trigeminal pain is perhaps the most important symptom of petrositis. Gradenigo first described a syndrome of external rectus paralysis and trigeminal pain associated with a discharging ear. In reality the term petrositis, which means inflammation of the petrous portion of the temporal bone, should be used as a general diagnosis and should have as subheadings (1) osteitis of the tip, i.e., inflammation of the bone separating the air cells of a pneumatized tip; (2) osteomyelitis of the tip, i.e., inflammation of the marrow and the bone of the tip; and (3) osteitis or osteomyelitis as the case may be, of the perilabyrinthine regions.

Petrositis usually subsides spontaneously with adequate drainage from the middle ear. Inadequate drainage may result in a chronically discharging ear or meningitis and death.

C. G. SUTHERLAND, M.D.

Osteitis Tuberculosa Multiplex Cystica of Fibula and Tibia Samuel Sanes and Warren S. Smith. *Jour Am Med Assn* April 14 1934 102, 1206-1208

This term is applied to cyst-like degeneration of the bones without joint involvement, characterized by the gradual onset of mild pain and swelling of the affected parts, distinctive roentgenographic features and a chronic benign course. Not infrequently it is associated with lupus pernio and Boeck's sarcoid. Histologically the bone showed epithelioid and giant-cell tubercles with little or no caseation. Tubercle bacilli are rarely demonstrated in examined tissues. Guinea pig inoculations occasionally give positive results for tuberculosis. The lesions are restricted usually to the small bones of the hands and feet. The authors report the second example of the lesion involving the long bones. Roentgen examination revealed decreased density of bone tissue with more or less oval excavation which was cyst-like in appearance. There was a thickening of the periosteum on the outer side of this cyst-like excavation. The chest showed evidence of an old tuberculous lesion. The primary lesion was a tuberculous osteomyelitis, this present lesion being merely a late phase of chronic localized tuberculous osteomyelitis. Post-operatively two roentgen treatments were given to the leg.

C. G. SUTHERLAND, M.D.

Osteochondritis of the Patella Including a Case with Multiple Epiphyseal Involvement Moses Gellman Jour Bone and Joint Surg January, 1934, 16, 95-104

In 1903 Osgood described a non traumatic affection of the tibial tubercle and in 1908 Köhler reported the first case of osteochondritis of the patella Harbin and Zollinger classified the types of osteochondritis as primary or secondary depending upon whether the primary or secondary centers of ossification were involved

Buchman described osteochondritis as a 'non-inflammatory, non infectious derangement of the normal process of bony growth occurring at the various ossification centers at the time of their greatest developmental activity' Ossification of the patella commences at the age of five or six years and the primary type of osteochondritis is common at these ages when the center is growing rapidly In rare cases the patella develops secondary centers of growth at about puberty The involvement of these centers when they do appear results in secondary osteochondritis

Various developmental anomalies such as accessory centers of ossification, are often noted in the patella These defects are bilateral in about two-thirds of the cases These aberrant ossification centers instead of fusing with the main body of the bone, may persist as separate centers at either pole All components of the bone may be involved by osteochondritis The quadriceps tendon above and the patellar tendon below may subject the patella to the irritative effects of severe traction The osteochondral line of the lower femoral epiphysis, and the tibial tubercle may be involved since these two sites are within the vulnerable area of this strong pull

The author reports two cases of this condition well illustrated by reproductions of roentgenograms The first case occurred in a white boy aged six and therefore represents the primary form of osteochondritis For several months the patient complained of tiring easily and occasional pain The physical examination was essentially negative except for mild tenderness of the patellæ Lateral roentgenograms revealed small ragged patellæ with numerous areas of lessened density and incomplete ossification and a tendency to fragmentation at the lower poles Rest in bed was prescribed Two years and four months later, all tenderness had long since disappeared Roentgenograms showed a nearly complete restitution of the bone structure in both patellæ It was noted however that trabeculations were somewhat coarser than usual and that there were several sharp spiculations about the periphery at various points

The second case, which was of the secondary form of osteochondritis occurred in a white boy aged twelve who complained of pain in the right knee of one year duration Physical examination revealed a small smooth rounded tender and slightly warm elevation on the outer pole of the right patella The left patella was clinically negative Roentgenograms

of the right knee showed marked disorganization of the bony structure of the patella There were also numerous areas of lessened density and incomplete ossification The lateral view of the unaffected left side revealed an even more disorganized and 'moth-eaten' patella Irregularities were also discovered at the osteochondral borders of the lower epiphysis of each femur After treatment for five and one half months both knees were symptomless Subsequently the patient complained of pain in the region of the tibial tubercles About two years and four months later roentgenograms showed the right patella thickened and longer with an area of lessened density in its upper third The left patella, except for appearing larger had a normal internal structure The fuzziness at the femoral epiphyses had disappeared

J N ANÉ M D

Bony Changes in Xanthoma Tuberosum Multiplex of the Hands H R Schinz Röntgenpraxis January 1934 6 22-25

Xanthomatous nodes on the fingers and hands may destroy the bone by pressure or the deposits may take place primarily in the bone The initial changes may clinically as well as roentgenologically be mistaken for gout A case is described with multiple involvement of the bones of both hands This disease belongs to the group of disturbances of the lipid metabolism as Gaucher's disease Niemann Pick's disease, and Schüller Christian's syndrome

HANS W HEFKE M D

A Radiologic Contribution to the Recognition of Late Changes in Bone Following Trauma Giuseppe Brancadora Archivio di Radiologia 1934 10, 72-77

The author illustrates the findings in a case he studied to bring out some of the late sequelæ of injury, as shown by skeletal changes which may be important both from a diagnostic and a medico legal standpoint

E T LEDDY M D

A Clinical and Radiologic Study of Cholesterol Lipoidosis of Christian Schuller Raffaello Liberti Archivio di Radiologia 1934, 10, 13-49

The author presents two cases of Christian Schuller's disease the pathologic anatomy and etiology of which he reviews in some detail In the first case, a patient aged seven years there was hydrocephalus, lesions in the ribs and radii and some peculiar lesions in the femurs In the second case a patient aged 13 years, there were lesions in the skull ribs vertebrae, humeri scapulas, pubes and femurs joints and soft parts The author illustrates the findings by prints of radiographs and emphasizes the salient points in differential diagnosis

E T LEDDY M D

BONE DISEASES (THERAPY)

Localized Focal Osteoporosis during Hypophyseal ovarian Disturbance Kurt Hatzky and Konrad Müller Fortschr a d Geb d Röntgenstr 1934 49, 117-127

Two cases are reported with a spotty porosis in the lower tibia and in the tarsal bones which are assumed to be in etiologic connection to hypophyseal-ovarian dysfunction Both improved under administration of calcium phosphorus, and "Vigantol" The symptoms of these patients differed from those usually seen in similar endocrine disturbances and resembled more the osteoporosis of inactivity following injury (Sudek) or the symptom-complex described by Leriche

HANS A JARRE, M D

CONTRAST MEDIA

Perforation of an Esophageal Diverticulum into the Trachea Ludwig Bayer Röntgenpraxis, January, 1934, 6, 31-34

Communication between esophagus and trachea is caused by malignant growths in the greatest number of instances In the case reported by the author the patient complained about pressure in the chest, cough, and temperature During roentgenologic examination the barium entered a diverticulum about midway between pharynx and bifurcation, at the same moment a violent attack of coughing began and the barium was seen in the trachea and the bronchial tree The patient died from a bronchopneumonia after a gastrotomy had been done The author believes that barium should not be used in similar cases but rather a small amount of iodized oil which might not be as liable to cause pneumonia

HANS W HEFKE M D

DOSAGE

The Dositron Sigmund Strauss Strahlen therapie 1934, 49, 712-717

The author describes a new type of measuring instrument equipped with a thimble ionization chamber and suitable for determining the output of x ray apparatus While it is possible to measure the r per minute during the treatment, the instrument does not integrate the dose

ERNST A POHLE M D, Ph D

The Roentgentherapy of Malignant Tumors with Protracted divided Doses Carlo Guidotti and Desiderio Perotti Archivio di Radiologia 1934 10, 78-90

The authors have treated 29 cases of cancer with very satisfactory results The technic is as follows 170 K V 3 ma 50 cm T S D 15 Cu + 2 Al in 50 ses sions of 60 r each (giving about 3 r per minute)

E T LEDDY M D

ELECTRICAL ACCIDENTS

The Peculiarities of Electrical Accidents Stefan Jellinek Röntgenpraxis January 1934 6, 1-12

The electrical accident presents symptom-complexes which are clinically and pathologically often very peculiar It is erroneous to believe that results of laboratory experiments on animals may be used as facts in the electropathology of humans Many such experiments have been done in order to determine the voltage and amperage which is dangerous to life It generally has been found that one tenth of an ampere can be tolerated by human beings without fatal results This theory however, does not hold true in clinical medicine Some persons exposed to many amperes remained alive and did not even become unconscious, others, who only touched a loose connection of a lamp and showed no external evidence of electrical injury fell dead and measurements done immediately showed a current of only a few milliamperes It is impossible to state even approximately a certain minimum amount of electric current which is not dangerous to life Certain other influences play an important rôle as meteorologic conditions, the psychic complex of fear of death or delayed and amateurish first aid Experience teaches that a very short exposure may be just as dangerous as a prolonged one Accidents with alternating current are more dangerous than with direct current If one is guided by the results of animal experiments concerning the localization of the electrodes one would again be wrong in the clinical application of the results The case is quoted of a boy who died immediately after touching an electric wire carrying 110 volts the current passed from the thigh through the foot into the ground And yet a man through whose body a current of 380 volts passed from one hand to the other did not even become unconscious, although the accident must ordinarily be considered as absolutely fatal

There are three somatic psychic factors which determine the injury by an electric current the resistance of the skin, the individual tolerance and the mental condition at the time of the accident

Wet skin is a much better conductor than a dry and calloused skin That is illustrated by a fatal accident to an engineer with soft moist hands who had touched an engine just previously touched by a laborer with hard calloused hands without any effect at all

There is unquestionably a difference in individual tolerance In certain accidents wherein two or more persons receive approximately the same amount of current the individual effects may be entirely different

One must also admit the existence of a psychic protective mechanism An electrician may intentionally touch both poles of a line carrying 110 or 220 volts for testing purposes without receiving any harmful effects at another time he may accidentally touch the same wire and may be severely injured or even killed In the first instance his mind was prepared for the current, in the other not In the rescue of victims of electrical accidents it is the man with a

prepared mind who is not going to be injured, while the fear stricken rescuer will probably be injured himself. Suicidal attempts by means of electricity are often not successful because the contact takes place with the mind prepared for it.

If death takes place it may be either immediate and synchronous with the electrical accident or it may be after a few seconds or even after an interval of hours. Cases have been reported in which the victims fell down unconscious, got up again without help, even talked about the accident, and then again collapsed after a few seconds or minutes and died this 'interrupted death'. Fairly often instances of such 'dead' persons having been revived have been recorded even after having been declared dead by physicians. All depends on quick and correct measures. The Silvester method of artificial respiration is the only physiologic and efficient one with which the writer is familiar. It is wrong to quit after half an hour of unsuccessful attempts; even two hours is not long enough. The author has himself seen cases in which the method was successful only after three hours of continuous application. Only the appearance of postmortem lividity should mean death. A physician present at the scene of the accident should sometimes do a venesection and lumbar puncture—of course, not during the first minutes of artificial respiration, because there is danger of air embolism and because the latter is of more importance. Resort may be had to intracardial injection of adrenalin.

Electric burns are entirely without inflammatory reaction and painless. A necrosis taking place after weeks is aseptic. Even very severe wounds with injury to bones and joints do not need radical surgical procedures. Strictly conservative measures are of the utmost importance. One must watch out for massive hemorrhage in the third or fourth week.

HANS W. HEFKE M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Roentgenologic Diagnosis of Perforation of Gallstones and Intestinal Obstruction Caused by Them. R. Kaiser. *Röntgenpraxis* January 1934 6: 12-16.

The author observed the wandering of a perforated gallstone from the duodenal cap to the ileum where it lodged. He was able to demonstrate on roentgenograms how the stone was first temporarily stopped in the duodenal cap and how it caused small intestinal obstruction a little later. At operation and autopsy the stone, the obstruction and the fistula between gall bladder and duodenum were seen. Also stones in the gall bladder. The latter were visualized on roentgenograms as negative shadows in a barium filled gall bladder.

HANS W. HEFKE M.D.

GRENZ RAYS

A New Integrating Measuring Instrument for Grenz and Light Rays. Siegmund Strauss. *Strahlentherapie* 1934, 49, 715-717.

An integrating dosimeter is described which has an ionization chamber for measuring grenz rays and a special photoelectric cell to determine the output of ultra-violet lamps.

ERNST A. POHLE M.D. Ph.D.

GYNECOLOGY AND OBSTETRICS

Relaxation of the Pelvic Joints in Pregnancy. Daniel Abramson, Sumner M. Roberts and Philip D. Wilson. *Surg. Gynec. and Obst.*, March, 1934, 58, 595-613.

The question of the relaxation of the pelvic joints in pregnancy has excited considerable interest and much controversy since the announcement of the Hippocratic theory of *disjunctio pelvica*. A large number of medical authors have written on the subject expressing views which differed markedly, some believing that pelvic joint relaxation was a normal and constant phenomenon and others that it was exceptional and pathological.

The authors compared measurements of the symphysis pubis obtained by means of the Johnson method of stereoroentgenometry with direct measurements on the film of the distance between the two pubic bones. The difference was found to be less than one millimeter, so all measurements were then made direct, adopting a fixed target film distance of 30 inches. A control series of 123 non pregnant females comprising 33 nulliparæ, 20 uniparæ, and 70 multiparæ, was next chosen. It was found that the average measurement for the symphysis pubis in the nulliparæ was 4.09 millimeters, for the uniparæ 4.15 millimeters, and for the multiparæ 4.6 millimeters. In the nulliparæ these measurements varied from 3 to 6 millimeters inclusively, while in the multiparæ the variation was from 1 to 8 millimeters, inclusively.

The difference noted between the appearance of the symphysis in the nulliparous and multiparous women is of considerable interest. In the former group the outline of the margins of the pubic bones was smooth with only a thin cortical layer of increased density. In the multiparous group there appeared to be a definite tendency to greater irregularity of the pubic margins of the symphysis with greater unevenness of the cortical outline. Occasionally small round areas of decreased density suggestive of cyst formation were noted. Age seemed to have little influence on the width of the symphysis.

X-ray measurements of the symphysis pubis were next done in a series of 71 males. The measurements obtained in this group were very similar to those obtained in the group of nulliparæ, as the variation noted was from 3 millimeters to 6 millimeters, with an aver-

age for the entire group of 44 millimeters. The pubic margins in this group were smooth and straight.

The first group of pregnant women studied consisted of 111 individuals who had been x-rayed during the last two months of pregnancy for the study of fetal measurements. A definite increase in the measurement of the symphysis pubis was noted. The average width was 77 millimeters and the measurements varied from 3 to 20 millimeters. The width of the symphysis was 9 millimeters in 24.3 per cent of this group.

The second group was chosen to study the effect of previous pregnancies in weakening the pelvic joints, and consisted of 25 primiparae in their last two months of pregnancy. The measurement of the symphysis pubis in this group averaged 79 millimeters with 28 per cent measuring 9 millimeters or over.

The third group comprised 93 observations on 38 individuals. Consecutive roentgenological measurements were made at different periods both antepartum and postpartum in this series of pregnant women. The results indicated that the process of relaxation began during the first half of pregnancy and that the parturition seemed to have very little effect in increasing the width of the symphysis. It was also noted that retrogression of the symphyseal relaxation began in the first month postpartum and was fairly well complete by the end of from three to five months.

The authors also studied pubic mobility by making two films on each patient. One film was taken with a push on the right leg and a pull on the other and the second film was exposed with the push and pull reversed. Comparison of films showed that the degree of pubic mobility varied with the amount of pubic separation being greatest in those patients with the wide gaps.

The authors are of the opinion that the causative factor of the relaxation of the pubic joints in pregnancy is similar to that advanced by Hisaw who isolated a hormone known as "relaxin" which he identified in the blood stream of guinea pigs, dogs, cats, sows, mares and rabbits during pregnancy.

The symptoms usually noted in pregnant women referable to the pelvic joints consist of pain in the region of the symphysis, sensation of movements of the bones when walking and pain and backache localized over one or both sacroiliac articulations. Examination usually reveals a waddling gait and on palpation, the separation may be noted and pain and tenderness elicited. Treatment is indicated to relieve symptoms and to prevent the development of chronic relaxation of the pelvic joints.

J. N. ANÉ, M.D.

INFLAMMATORY DISEASES

The Principles of Roentgentherapy in Inflammatory Disease, Otto Dyes. *Strahlentherapie* 1933 47:160-178.

The author presents a critical review of the principles and assumptions underlying the use of roentgen

rays in inflammatory disease. A very complete bibliography (6 pages in small type) is appended.

ERNST A. POHLE, M.D., Ph.D.

JOINTS

A Case of Chondromatosis of the Shoulder Joint. Aladar V. Szigethy. *Röntgenpraxis*, January 1934, 6, 28-31.

Chondromatosis of joints is usually seen in only one joint most frequently in the knee, elbow or hip joint. It has been observed in shoulder and ankle joints only very rarely. The author describes a case of chondromatosis in the shoulder joint in a man 51 years old who had suffered an injury to this joint a few years before the clinical symptoms began. The secondary inflammatory changes in the joint were benefited by small doses of roentgentherapy.

HANS W. HEFKE, M.D.

A Study of 100 Cases of Subdeltoid Bursitis. Mark H. Rogers. *Jour. Bone and Joint Surg.*, January 1934, 16, 145-150.

The author discusses the anatomy of the subdeltoid bursa and related structures, the classification and the relation of subdeltoid bursitis to trauma and infection. The supraspinatus muscle arises from the scapula and is attached to the humerus in the same area as the capsule of the joint. This muscle after it becomes spread out lies just above the joint capsule and beneath the floor of the subdeltoid bursa. The bursa is a thin-walled structure lying just beneath the deltoid muscle.

Calcified areas are shown by x-ray examination in the acute and sometimes in the chronic cases of subdeltoid bursitis. These areas are situated on the superior surface of the joint capsule and supraspinatus tendon. They are not within the bursal sac but the posterior wall of the bursa lies on top of the calcification which is believed to be essentially a calcium carbonate.

The author groups the cases of his series into three classes: (1) the acute fulminating type, (2) the chronic adhesive type and (3) the traumatic type. The acute type is of sudden onset and reaches its greatest intensity in from three to four days. The chronic adhesive type is of slower onset and presents a different clinical picture from the first group. In the chronic type there is no acute pain unless the arm is moved. The traumatic type follows a history of a fall or a twist of the arm.

The average age of the 29 cases of the acute fulminating type was 48 years. The group of chronic cases consisted of 46 cases with an average age of 56 years. Twenty-five cases made up the traumatic group with an average age of 55 years. In this series no case of subdeltoid bursitis was found in a patient under 30 years of age.

The author also studied the relation of focal infection to subdeltoid bursitis and failed to find any evidence that the condition of the shoulder resulted from infection. Of interest, however, was the high incidence of diabetes in the group of chronic cases in which 18 patients were diabetics.

J N ANÉ, M D

LIGHT THERAPY

Modern Finsen Treatment Svend Lomholt Strahlentherapie, January, 1934, 49, 1-64

On 64 pages, the director of the skin clinic of the Finsen Institute, in Copenhagen, outlines the indications for and the results to be expected from Finsen light therapy. The article does not lend itself to abstracting and is recommended for study in the original. One observation of interest to the radiologist may be mentioned that λ -ray late reactions, i.e., atrophy telangiectasis, ulcers are often benefited by proper Finsen treatment.

ERNST A POHLE, M D Ph D

NEURALGIA

The Physical Methods of Treating Neuralgias G Cola Arch di Radiologia 1933 11, Fasc 3 pp 560-578

Seventy three cases of neuralgia (33 sciatic 16 trigeminal 11 brachial plexus 9 intercostal 2 femoral and 2 occipital) treated by various combinations of the physical agents are reported by Cola. In general he gives roentgentherapy first place in the treatment of these painful disorders and he reviews some of the theories which have been advanced to explain the analgesic action of λ ray.

E T Leddy, M D

THE OVARIES

The Biology of the Irradiated Ovaries Dermoid in the Ovary of a Woman Treated by Radium for Carcinoma of the Cervix Joachim Granzow Strahlentherapie 1934 49, 694-702

A woman, 41 years of age, had a carcinoma of the cervix (Group 3). She was treated by intratubercine radium application followed by deep λ ray therapy to the pelvis. Amenorrhea promptly occurred and 27 months after radiation therapy the patient was clinically free from all cancer symptoms. Five months after the last examination in other words 2 years and 8 months after the treatment a tumor of fist size was found in the left ovary which after having been removed showed histologically, a typical benign dermoid cyst. The other ovary revealed the typical picture found following roentgen sterilization. There was no evidence of carcinoma in the uterus or the cervix. The author concludes from this observation that amenorrhea after irradiation is no proof for the anatomic or biologic elimination of the ovaries.

ERNST A POHLE, M D Ph D

OXYGEN PNEUMOPERITONEUM

Oxygen Pneumoperitoneum in the Diagnosis and Treatment of Tuberculosis of the Genitalia, Intestine, and Peritoneum Irving F Stein Surg, Gynec and Obst March, 1934, 58, 567-577

The author discusses the value of oxygen pneumoperitoneum in the diagnosis and treatment of tuberculous peritonitis, cites 64 cases from the literature and reports six additional ones. In 1872 Spencer Wells operated upon a woman for ovarian cyst but found instead tuberculous peritonitis. A cure followed the opening and closing of the abdomen. Wells however did not appreciate the significance of this result and the surgical treatment of tuberculous peritonitis became a recognized procedure only after Koenig advocated it in 1884.

Hertzler has pointed out there are about twenty theories advanced to explain how simple laparotomy cures tuberculosis of the peritoneum. Lauenstein believed that the removal of fluid and exposure to light resulted in the cures reported. Norris held that the removal of fluid alone was responsible for the good results obtained. Sterilized air, filtered air, atmospheric air, nitrogen and oxygen all have been employed in the treatment of tuberculous peritonitis with good results. The author is of the opinion that the inflation of the abdomen with from 100 cc to 1,000 cc of oxygen by the puncture method should replace the surgical exploration.

The diagnosis of tuberculous salpingitis is considered difficult, although it may be suspected after a careful study of the patient's history and results of bimanual and abdominal examinations. This condition is responsible in from 5 to 10 per cent of inflammatory lesions of the fallopian tubes, and is a common cause of salpingitis in the virgin. By means of diagnostic pneumoperitoneum, alterations in the size, shape, density and relationship of the various pelvic organs and especially the presence or absence of adhesions may be demonstrated clearly in the x-ray film.

The preparation of the patient for this procedure consists in emptying the bowels by means of a cleansing enema about an hour before treatment. One half hour before treatment morphine sulphate alone or with scopolamine hydrobromide should be administered. The bladder should be emptied just before treatment. The skin of the lower abdomen is prepared by alcohol, followed by 2 per cent mercurchrome solution. A firm inflexible needle 3 inches in length fitted with a stylette is employed for the puncture without local anesthesia. A point one inch to the left and slightly below the umbilicus should be selected for the puncture. If fluid is present about one liter may be removed by trocar and the trocar used for the insufflation. The author employs the apparatus used for the Rubin patency test substituting an oxygen tank for that of carbon dioxide. If a needle is employed no dressing is required. The patient should be kept flat both on the λ ray table and during transportation to avoid 'shoulder pain' caused by gas entering the right sub

diaphragmatic space Within 48 hours all signs of oxygen have usually disappeared and the procedure may be repeated at this time if indicated In some of his cases the author combined the use of oxygen pneumoperitoneum with uterosalpingography

The following conditions are recognized as contra indications to this procedure Morbund patients, the plastic form of tuberculosis, grave pulmonary tuberculosis, advanced ulcerative intestinal tuberculosis Pregnancy is regarded by some as a contra indication but the author is of the opinion that during the first three months when the uterus is not likely to be traumatized by puncture this procedure may be safely used

J N ANÉ, M D

PARATHYROIDISM

Hyperparathyroidism A Common and Polymorphic Condition as Illustrated by Seventeen Proved Cases from One Clinic Fuller Albright, Joseph C Aub, and Walter Bauer Jour Am Med Assn, April 21, 1934 102, 1276-1287

Seventeen cases are reviewed, a parathyroid tumor was removed in each instance The disease is usually due to a functioning adenoma of the parathyroid glands, increased production of the hormone a disturbance in the metabolism of calcium and phosphorus The easily measurable manifestations of this disturbance are an increased serum calcium level, a decreased serum phosphorus level and an increased excretion of both elements in the urine, demineralization of the bones, multiple cysts and benign tumors of bone tissue with giant cells Clinical types are Classic hyperparathyroidism, osteoporotic hyperparathyroidism, hyperparathyroidism with nephrolithiasis, hyperparathyroidism with renal insufficiency acute parathyroid poisoning and hyperparathyroidism simulating (or complicated by) Paget's disease In the majority of cases the disease smolders on for years crippling but not killing Fatal issue is usually from renal involvement

There may be no skeletal changes demonstrable by x rays Demineralization must involve the entire skeleton if at all Urinary calculi or punctate deposits of calcium in the kidney parenchyma should be looked for in cases of questionable hyperparathyroidism Fluoroscopy and roentgenography of the anterior mediastinum may aid in the localization of a parathyroid tumor

Failure to make the diagnosis is regrettable in that therapy for it is highly successful

C G SUTHERLAND M D

PARONYCHIA (THERAPY)

X-ray Therapy of Paronychia W Jessen Strahlentherapie November, 1933 48, 599 600

The author recommends the treatment of paronychia by x rays He gives 30 per cent H E D filtered

through 4 mm Al, in one sitting, to be repeated if necessary after ten days The results were in his experience, most excellent

ERNST A POHLE, M D Ph D

PAROTITIS

Parotitis and Roentgen Therapy E N v Oettingen Strahlentherapie, 1933, 46, 651-654

The author treated 25 cases of parotitis with roentgen rays, applying 25 per cent H E D about two or three times The results were entirely unsatisfactory As a possible explanation he offers the fact that his patients were mostly post operative surgical cases

ERNST A POHLE M D Ph D

THE PATELLA

A Radiologic Study of the Normal and Pathologic Patella Bona Raviola Archivio di Radiologia 1933 11 No 4 pp 751-776

The author discusses the normal patella and then describes the lesions found among 74 cases of pathologic patellas the most important of which are illustrated by radiographs

E T LEDDY, M D

RADIOLOGY, PRACTICE OF

Radiodiagnosis in Clinical Medicine Editorial Brit Med Jour April 7 1934, No 3822 627, 628

Since the discovery of the roentgen rays or x rays by Roentgen their use has extended into many departments of science but their application to medicine has probably been the most fruitful of all The first use of the roentgen rays in medical science consisted of the study of the skeleton and the search for foreign bodies In 1896 Bouchard first made use of the natural transparency of the lungs compared with the shadows of the heart and skeleton and thus initiated chest radiography Then followed the introduction of the various contrast media such as bismuth and barium salts lipiodol and opaque dyes for gall bladder and kidney examinations

The field of roentgenology has become so broadened and the need for special study and training in the accurate interpretation of the roentgenograms so important that a special branch of medical practice has arisen It must be remembered that while we may feel competent to express an opinion on an ordinary photograph of a scene or person the accurate interpretation of the roentgen film is different for it represents shadows of a three-dimensional world imposed on a two-dimensional plane Bécélère said The x rays are never mistaken It is we who make the mistake of demanding from them more than they can give or of interpreting their language wrongly It is therefore necessary for one to

have a thorough knowledge of anatomy and pathology, and sufficient training and experience in normal and abnormal appearances of roentgen anatomy. No interpretation should be attempted without considering the history, and physical and clinical laboratory examinations of the patient. Consultation between the roentgenologist and the practitioner in charge of the case is very valuable. The practitioner should not only be a clinician of experience, but must have some knowledge of radiodiagnosis.

The demand for information and instructions in roentgenology is shown by the appearance of text-books and manuals devoted to various aspects of radiological practice. In the author's opinion one of the most recent and most satisfactory of the text-books written to instruct the clinician is the manual of radiodiagnosis written by Dr Ledoux-Lebard, of the radiological clinic in the Paris Faculty of Medicine.

J N ANÉ M D

ROENTGEN RAYS IN INDUSTRY

The X ray in the Study of the Catgut Ligature
Paul F Ziegler and George L Clark Surg, Gynec and Obst March 1934 58 578-589

The authors studied the structure of catgut ligature under various conditions by means of the x-ray diffraction method. The x ray wave lengths employed were $1/6000$ as long as yellow light and x rays and light are diffracted by suitable gratings. Crystalline substances serve as three dimensional diffraction gratings for the x ray because the atoms and molecules lie upon parallel planes which are spaced apart at distances comparable with the x ray wave lengths. The diffraction pattern obtained for any crystalline substance depends on the arrangement of the ultimate structural units characteristic of the substance in question. The importance of such a study is. The determination of the basis for selection of raw catgut material the selection of suitable techniques for the alteration of structure from a less preferred to a more preferred orientation and the possession of more exact knowledge of the mechanism of chromicizing.

It was previously determined by means of the x ray diffraction method that ramie fibers which represent one of the varieties of cellulose are built up from a great number of very small crystal units called crystallites or colloidal micelles, which are so arranged in space that a common direction in them is parallel to the axis of the fiber. This represents a high degree of preferred orientation. Cellophane another variety of cellulose on the other hand, is made up of these same little cellulose crystallites arranged at random. Cotton was found to represent an intermediate state of arrangement of these small units.

The authors found that raw catgut had a higher degree of preferred orientation than catgut which had undergone further processing, provided that tension and stretching were not applied during processing for elevated temperatures and swelling disarranged the

micellar arrangement. It was shown also that different samples of catgut from different manufacturers showed considerable variation in structure. It was reasoned also that catgut fibers which were rendered plastic by preliminary swelling could be pulled by suitable tension so that the micelles would be placed in more perfect alignment. The x ray diffraction patterns obtained by these experiments proved this to be the case.

Since the more perfectly oriented catgut fibers are stronger in general than those with less preferable alignment of micelles, the x ray diffraction pattern also indicates tensile strength. It is likewise known that tensile strength increases with gauge or diameter. The authors therefore, studied the effect of increasing the ratio of strength to gauge by decreasing the gauge without changing the tensile strength. A number of strands of raw catgut were wetted and one half of each original strand was then allowed to dry under tension. The other halves served for comparison. This experiment showed a marked increase in strength per unit gauge for gut dried under tension. This experiment was repeated, using catgut which had been subjected to high temperature and which had been stored in 98 per cent alcoholic solution and the results were the same. It is known that ligatures near knots remain after other portions are digested. X-ray patterns showed that at knots an improved preferred orientation is produced by the tension exerted.

J N ANÉ M D

THE SPINE

Bacillus Proteus Osteomyelitis of the Spine Seth Selig Jour Bone and Joint Surg January, 1934, 16, 189-192

The author reports the case of a male aged 37, who was admitted for hospitalization with symptoms of left ureter colic. Roentgenographic examination revealed a shadow in the course of the left ureter, and at cystoscopic examination an obstruction of the left ureter was noted. Six days after the cystoscopy, the patient had a chill and a rise of temperature to 105 degrees. Blood culture showed *Bacillus proteus*. The patient had six chills and later passed a calcium oxalate stone and all symptoms ceased.

Pain in the back of the neck was noted by the patient on the day of his discharge from the hospital. This increased in severity and about a week later he was readmitted to the hospital. At this time there was noted marked restriction of motion of the cervical spine in all directions. The temperature was 103.5 degrees and the patient complained of tenderness over the fourth to the seventh cervical vertebrae. Blood cultures and cultures of the urine were positive for *Bacillus proteus*. Roentgenographic examination revealed a definite narrowing of the intervertebral space between the fifth and sixth cervical vertebrae.

The treatment of this condition consisted of the application of traction by means of the Crile traction

apparatus The pain was relieved and the temperature fell to normal About five weeks later roentgenograms revealed an osteomyelitis of the fifth and sixth cervical vertebrae with collapse of both bodies Treatment was continued by plaster spica and subsequently by a jury mast attachment Roentgenographic examination four and one half months later showed bony fusion of the fifth and sixth cervical vertebrae

J N ANÉ M D

An Atypical Case of Tuberculosis of the Spine
Charles K Petter and J P Medelman Jour Am Med Assn, April 28 1934, 102, 1378, 1379

This is a case report of a female aged 50 who had tuberculosis of the left knee in 1909 and of the left elbow in 1912 In 1921 a laparotomy was performed and tuberculosis of the right ovary, appendix and peritoneum was found Later, in 1921 the patient had pleurisy with effusion on the left side and went to a sanatorium for two years In January 1927, a large gland appeared in the left groin and a few days later an abscess pointing in this region was aspirated In November 1931, she entered Glen Lake Sanatorium with a mass in the left lumbar region a discharging left ear and cervical adenitis There had been a weight loss of 25 pounds and progressive weakness over a two-year period

Roentgenographic examination showed rounded areas of bone destruction in the eleventh and twelfth dorsal and first and second lumbar vertebrae The left sacro-iliac was involved by a destructive process The patient died in June, 1932, and the anatomic diagnosis was (1) tuberculous spondylitis (2) tuberculous peritonitis, (3) tuberculous lymphadenitis (4) left psoas abscess (5) pleural adhesions, (6) pericardial adhesions Actinomycosis and metastatic carcinoma were considered from the roentgen appearances

C G SUTHERLAND M D

Delayed Appearance of Deformity in Vertebral Body Fractures O O Feaster Jour Am Med Assn Feb 24 1934, 102, 598-599

The author has observed three cases in which, following comparatively mild forms of trauma there have been fractures of vertebrae not demonstrable in roentgenograms made shortly after the injury but which were seen in roentgenograms made within the following three weeks In such cases in which discomfort or disability persists re-examination is requested The lesion has been found from five to seven vertebrae above the site of pain The lateral view of the bodies is usually the only film of definite value

CHARLES G SUTHERLAND M D

SPLEEN

The Effect of Roentgen Irradiation of the Spleen on the Iron Metabolism in the Animal Organism

J J Arkussky Strahlentherapie, 1934, 49, 455-462

The spleen of rabbits was exposed to roentgen rays with the following technic K V not stated 0.4 mm Cu, 6 X 8 cm field 26 min (710 r) The metabolism was carefully controlled before and after the exposure Second and third treatments were given at certain intervals It appeared that the application of high doses to the spleen as well as removal of the spleen reduced the excretion of iron The liver apparently plays an important rôle in the deposition of iron as proved by histologic studies

ERNST A POHLE M D Ph D

THORAX

Simultaneous Bilateral Spontaneous Pneumothorax Report of a Case with a Brief Discussion of the Literature D E Markson and Warren Johnson Jour Am Med Assn, March 17 1934, 102, 826-828

Bilateral spontaneous pneumothorax, occurring in the apparently healthy is an extremely rare disease McMahon found less than 50 cases reported from all causes

The authors report a case occurring in an apparently healthy young man within a few hours after the onset Within 24 hours after pitching a baseball game he noticed a severe lumbar pain which persisted and in the course of an hour was accompanied by dyspnea which became rapidly more intense Fluoroscopic examination about six hours after the onset showed the right lung to be almost completely collapsed and the left about 50 per cent Three thousand c c of air were removed from the right and 2,000 from the left side The patient immediately began to breathe easier his color changed to normal hue, and he slept comfortably in a fully recumbent position

Very little is known about the supposedly idiopathic types of spontaneous pneumothorax Kjaergaard reviewing all available material concluded that ruptured valve vesicle cysts due to scar tissue emphysema or congenital malformation of the lung tissue accounts for the cause in many cases of this disease He suggested congenital disposition to valve vesicle He cited cases in which a spontaneous pneumothorax simplex developed in more than one member of the family In the case here reported the history of the sudden suffocation of a maternal uncle together with roentgenologic evidence of a left apical cyst pointed to a congenital cyst as the possible etiologic factor Emphysema is a rare cause Traumatic bilateral cases sometimes run a benign course Benign cases of spontaneous pneumothorax have been reported as occurring in tuberculosis patients It is probable in such cases a valve vesicle may have been the cause the tuberculosis playing no rôle whatever

CHARLES G SUTHERLAND M D

Some Disorders of the Esophagus Arthur F Hurst Jour Am Med Assn Feb 24 1934 102, 582-587

The author discusses four esophageal syndromes *The dysphagia of anemic women, achalasia of the cardiac sphincter (so called cardiospasm) chronic peptic ulcer of the esophagus, and the recurrent hiatus hernia syndrome of von Bergmann*

In the first of these conditions the anemia is always of the hypochromic microcytic type, and it is generally associated with achlorhydria or hypochlorhydria. The condition occurs only in middle aged women and is regarded as a complication of simple achlorhydric anemia. Atrophic glossitis is constantly present. The dysphagia is the result of disturbance in the neuromuscular mechanism, apparently the result of the atrophic inflammation of the mucous membrane in the neighborhood. Either the nerve endings are atrophied and fail to convey the afferent impulses, which results in the reflex relaxation of the sphincter, or the ganglion cells of Auerbach's plexus are involved and fail to convey the efferent impulse to the sphincter.

In *achalasia of the cardiac sphincter (so called cardiospasm)* obstruction is caused by absence of the relaxation of the sphincter which normally occurs when in the act of swallowing, a peristaltic wave reaches it. This is the result of organic disease of Auerbach's plexus the only well-established example of a localized disease of the autonomic nervous system.

Peptic ulcer of the esophagus is generally regarded as a very rare condition. Discomfort and pain occur under the lower extremity of the sternum while solid food is being eaten and less frequently half an hour or more after meals. It often radiates to the back. At first it lasts for only a few minutes and is relieved by alkalis, but later it is prolonged and followed by regurgitation so that the patient often becomes afraid to eat. Hematemesis, which may be severe and fatal is a common complication but perforation into the mediastinum, pericardium, or peritoneum is the usual cause of death. A fibrous stricture may develop and lead to more or less complete obstruction.

In *the recurrent hiatus hernia syndrome of von Bergmann* in contrast with the familiar type of non-traumatic diaphragmatic hernia which results from congenital shortness of the esophagus, the esophagus is of normal length. The tissues that surround it as it passes through the hiatus esophagus must be abnormally lax. This may sometimes be congenital but the greatly increased frequency in elderly persons suggests that it is mainly due to senile changes in the tissues. The hernia is generally intermittent but it may become fixed and permanent. A case can be most successfully demonstrated when the patient drinks the barium suspension while lying flat on the back.

CHARLES G. SUTHERLAND M.D.

incidence is found in warm, moist climates, chiefly in adult life, and more often in males. The association of the infection with chronic debilitating diseases has often been noted. The organisms have been found frequently as secondary invaders in pulmonary tuberculosis and in neoplasms of the lung. Primary infection in man is generally attributed to direct contact or inhalation. The classification into types is based chiefly on the severity of the infection. The acute case may have a sudden onset, with a rapid progression to a fatal termination. The chronic case is usually insidious in onset and tends to follow a protracted course, with frequent remissions and exacerbations.

Röntgentherapy is reported to be of considerable benefit. Potassium iodide in large doses, thymol by mouth, gentian violet and methylene blue intravenously have been used with fair results.

C. G. SUTHERLAND M.D.

Advantageous Use of Filters over Parts of Roentgenograms Especially in Chest Exposures. A Determination. Fortschr. a. d. Geb. d. Röntgenstr., 1934, 49, 170-175.

To obtain optimal roentgenographic quality in spite of pronounced difference in density, for instance good quality in both lung fields in the presence of unilateral dense pleuropulmonary shadows, thoracoplasty etc., it is proposed to increase the exposure by from 30 to 50 per cent so as to properly penetrate the dense side and to shield simultaneously the transparent side by interposition of a filter of from 0.05 to 0.1 mm. Cu between patient and cassette.

HANS A. JARRE M.D.

Etiology, Development and Significance of Pleural Calcifications and Ossifications. Klaus Kuhlmann. Fortschr. a. d. Geb. d. Röntgenstr. 1934, 49, 147-154.

Pleural calcifications and ossifications develop at times as sequelæ to hemothorax, pleural empyema—at times of tuberculous etiology—but also following the common non-tuberculous types of exudative pleurisy. A minimum calcium content and an acid reaction of tissues as exists when necrotic material is in contact with healthy tissue must be present to permit development of young connective tissue which later on may respond to certain stimuli. These conditions are reviewed briefly and a few cases are reported.

HANS A. JARRE M.D.

Atypical Forms of Dry Pleurisy. A Radiologic and Clinical Study. Samuel Brown. Jour. Am. Med. Assn. Jan. 20, 1934, 102, 193-196.

Certain atypical forms of pleurisy, namely, the interlobar, the mediastinal, the paravertebral and the diaphragmatic, may best be recognized by the radiologic method. Studies in both the anteroposterior and

Pulmonary Moniliasis. Henry J. Bakst, J. Beach Hazard and John A. Foley. Jour. Am. Med. Assn., April 14, 1934, 102, 1205-1213.

Branchiopulmonary moniliasis has been reported from practically all parts of the world. The maximum

the lateral positions enable one to localize any abnormal shadow in the lung field and determine its exact relationship to the interlobar fissures, the mediastinal structures, the spine and the diaphragm. Thickening of the interlobar pleura in the horizontal fissure is more readily recognized in the anteroposterior position, that of the interlobar pleura of the oblique fissures is more readily recognized in the lateral position of the chest.

In acute or subacute dry pleurisy involving the outer lobar pleura, the mediastinal pleura, or the paravertebral pleura, pain is seldom present. An annoying, dry cough may be the most troublesome symptom. Physical examination of the chest rarely reveals anything abnormal. A roentgen examination will invariably disclose an abnormal shadow in the lung field.

The roentgen characteristics depend on the region involved and the extent of the lesion. In the lateral position the abnormal shadow will overlap the heart or spine, or both, depending on the extent of the area involved. In diaphragmatic pleurisy the diaphragm is found elevated and its outline is more or less irregular as a result of a fibrous deposit.

CHARLES G. SUTHERLAND, M.D.

Partial Pulmonary Atelectasis. A Post operative Complication. A Taylor and C Zweifel. *Fortschr a d Geb d Röntgenstr.*, 1934, 49, 157-161.

Two cases of partial pulmonary atelectasis are reported, with emphasis on the resulting mediastinal shifting. The symptomatology of this condition has attracted little attention in the German literature, while it is well established in English and American medicine.

HANS A. JARRE, M.D.

THYROID (DIAGNOSIS)

The Influence of the Thyroid on the Skin Reaction for X rays of Medium Hardness. F. Ellinger. *Strahlentherapie*, 1933, 48, 97-102.

In rabbits following thyroidectomy, the skin reaction on the ear occurred much slower than was the case with normal animals. Irradiation was produced at 100 K.V., 4 ma. and filtered through 2.0 mm. Al (half value layer in Cu 0.16 mm). Doses of 150 and 700 r were used.

ERNST A. POHLE, M.D., Ph.D.

THYROID (THERAPY)

X-ray Treatment of Exophthalmic Goiter. Charles S. D. Don. *Brit. Med. Jour.*, April 28, 1934, No. 3825, 746-748.

The author discusses the x-ray treatment of exophthalmic goiter in a series of cases which have been under observation for a minimum period of one year. The results of this form of therapy were determined by a

study of the variation in the weight, the basal metabolic rate, the pulse rate, the patient's symptoms and signs and their own opinion as to the value of the treatment.

In the treatment of these cases two areas were treated at first twice a week, then once a week, and thereafter with increasing intervals between treatments as the patient improved. The following factors were employed: 6.5 inch spark gap, 3 milliamperes, 3 mm. aluminum filter, time 5 minutes. With the apparatus employed, this exposure was equal to a half Sabouraud pastille dose. Rest and a nourishing diet were insisted upon, but iodine was not prescribed.

The cases in this series were divided into "cure," "improvement," and "failure." Of the 103 patients beginning treatment, 10 discontinued it during the first three months and were treated by surgery. It was impossible, therefore, to classify these ten cases because of lack of sufficient time to determine the results of x-ray therapy. Of the remaining 93 cases at the end of six months treatment seven had been operated on, and at the end of a year six more had been referred for surgery. At the end of the two-year period seven additional patients were operated on, and at the end of three years, one additional patient was treated by surgery. The author is of the opinion that these cases referred to surgery after the six-month period cannot all be classified as failures, for a considerable number showed improvement. Of the seven patients referred for surgery after six months of x-ray therapy, four were classed as failures and three were listed as "improvement." Of the six operated on at the end of a year, five were classed as "failure" and one as "improvement." The final results are: Cure 38, improvement 30, failure, 25.

While it was noted that recurrences and relapses may occur in those patients considered cured, it was also observed that the percentage of cures and improved cases was higher in a series of cases treated for more than one year than in a series treated for only one year. The author is of the opinion, therefore, that the extension of x-ray treatment beyond one year, when necessary, is justified, as some cases do not reach their maximum improvement at the end of one year. The reported series is made up from the working classes and therefore it was the aim to obtain satisfactory results in one year. The author believes that this wish, plus the low surgical mortality rate experienced in his hospital, probably accounts for the fact that a greater number of cases were operated on than Dr. Murray found necessary in his cases. Murray found surgical treatment advisable in about one twelfth of the cases of his series treated by the x-rays.

J. N. ANÉ, M.D.

Roentgen Therapy of Basedow's Disease. Franz Bardach. *Strahlentherapie*, 1934, 49, 618-633.

The author first reviews briefly the history of radiation therapy in Basedow's disease. It appears that small doses are advisable in the beginning in order to avoid severe reactions due to a sudden increase of

secretion Normal thyroid tissue is apparently not very radiosensitive, but the pathologic thyroid responds readily to 40 r According to Schwarz following irradiation the nervous symptoms are improved in 100 per cent, tachycardia in 65 per cent, increase in weight occurs in 65 per cent the exophthalmos disappears in 37 per cent and the struma reduces in 20 per cent In favorable cases, relief may be expected in from 10 to 30 days after the treatment has been started the objective symptoms should improve within from 3 to 4 weeks Some radiologists use two small fields over each lobe of the thyroid and an additional thymus field It seems best however, to apply one large frontal area at 50 cm distance An initial dose of 60 r seems to be safe a total of from 1100 to 1600 r administered in from 12 to 24 weeks is sufficient to bring about results Opponents of irradiation claim a high mortality for roentgentherapy and also point to a marked fibrosis after treatment, thereby rendering a future operation difficult There is nothing in the literature to support the first claim, and the fibrosis can certainly be avoided with proper technic The author recommends therefore trial of irradiation in all typical cases of Basedow's disease If there is no improvement after from 2 to 3 months, operation seems advisable Hyperthyroidism with pressure symptoms should as a rule be operated upon, the same holds true of toxic adenoma In the latter group patients who are inoperable because of severe toxic symptoms can often be made operable by irradiation

ERNST A POHLE M D Ph D

The Roentgentherapy of Flajani Basedow's Disease
Luigi Ferretti Archivio di Radiologia 1934, 10, 50-71

The author reports 12 cases of exophthalmic goiter which he treated with x rays with a favorable result He favors mild doses of from 15 to 20 per cent of an erythema dose using 170 K V 2 ma 0.2 Cu + 2 Al, at 31 cm T S D to be repeated every two weeks for five treatments Following this treatment there must be an interval of 40 days after which the cycle is repeated and then a third time if indicated after from 6 to 8 weeks Meanwhile the patient is under careful medical supervision The author feels that this method of treatment is of value in the great majority of cases

E T LEDDY M D

TUBERCULOSIS (DIAGNOSIS)

The Latent Period in the Roentgen Diagnosis of Pulmonary Tuberculosis Preliminary Report Leo G Rigler and Frederick B Exner Jour Am Med Assn May 26 1934, 102, 1750-1754

It is obviously most difficult to date actually the occurrence of a tuberculous infection in the human being It is often possible to state with accuracy the time of onset of symptoms but that may be long after the on-

set of the infection Only one means of great accuracy is at hand : e the tuberculin skin test The interval between the occurrence of the infection and the establishment of a positive skin test must be very short probably only a few weeks or less In the typical first infection tuberculosis, as seen in young children the development may be very rapid, and the lesions are detected in the roentgenogram with ease because of their extensive character

The authors have observed a number of cases of pulmonary tuberculosis developing in medical students and internes who have previously had repeated tuberculin skin tests, chiefly by the Mantoux method, and have also had repeated roentgenograms of the chest In some they have been able to trace exactly the time of onset of the infection and the period of time that has elapsed before roentgen signs in the lungs became apparent The roentgenogram they conclude is an exceedingly sensitive method of detecting pulmonary tuberculosis

C G SUTHERLAND, M D

TUBERCULOSIS OF SKIN

Roentgen Therapy of Lupus Karl Zieler Strahlentherapie, December 1933, 48, 670-679

X rays are beneficial in the treatment of tuberculosis of the skin However, they should be used as a rule, only in connection with other therapeutic procedures Small doses cannot be recommended The author has seen good results with from 80 to 100 per cent E D (3 mm Al, H V L in Al 4.0 mm), given twice at an interval of from 6 to 8 weeks This dose should not be repeated more than three times

ERNST A POHLE M D Ph D

TUMORS (DIAGNOSIS)

The Roentgen Diagnosis of Renal Tumors Thomas Canigiani Fortschr a d Geb d Röntgenstr 1934, 49, 128-135

This paper reports comparison of excretion and retrograde (instrumental) pyelography in six cases of renal tumors In these indigokarmin was excreted well by both kidneys but no excretion urographic images were obtained of the involved kidneys while typical filling deficiencies and deformities were shown by instrumental pyelography The latter method is given preference for tumor diagnosis The fallacy of good excretion of indigokarmin is emphasized and the lack of parallelism between excretion of dyes and excretion urographic demonstrability is to be noted

HANS A JARRE M D

TUMORS (THERAPY)

Study on the Tissue Respiration and Glycolysis in Obstetrics and Gynecology Part V Effects of X ray

the lateral positions enable one to localize any abnormal shadow in the lung field and determine its exact relationship to the interlobar fissures, the mediastinal structures the spine, and the diaphragm. Thickening of the interlobar pleura in the horizontal fissure is more readily recognized in the anteroposterior position, that of the interlobar pleura of the oblique fissures is more readily recognized in the lateral position of the chest.

In acute or subacute dry pleurisy involving the outer lobar pleura, the mediastinal pleura, or the paravertebral pleura, pain is seldom present. An annoying, dry cough may be the most troublesome symptom. Physical examination of the chest rarely reveals anything abnormal. A roentgen examination will invariably disclose an abnormal shadow in the lung field.

The roentgen characteristics depend on the region involved and the extent of the lesion. In the lateral position the abnormal shadow will overlap the heart or spine or both, depending on the extent of the area involved. In diaphragmatic pleurisy the diaphragm is found elevated and its outline is more or less irregular as a result of a fibrinous deposit.

CHARLES G. SUTHERLAND, M.D.

Partial Pulmonary Atelectasis. A Post operative Complication. A. Taylor and C. Zweifel. Fortschr. a. d. Geb. d. Röntgenstr., 1934, 49, 157-161.

Two cases of partial pulmonary atelectasis are reported with emphasis on the resulting mediastinal shifting. The symptomatology of this condition has attracted little attention in the German literature, while it is well established in English and American medicine.

HANS A. JARRE, M.D.

THYROID (DIAGNOSIS)

The Influence of the Thyroid on the Skin Reaction for X rays of Medium Hardness. F. Ellinger. Strahlentherapie, 1933, 48, 97-102.

In rabbits following thyroidectomy the skin reaction on the ear occurred much slower than was the case with normal animals. Irradiation was produced at 100 K.V., 4 ma., and filtered through 2.0 mm. Al (half value layer in Cu 0.16 mm.). Doses of 150 and 700 r. were used.

ERNST A. POHLE, M.D., Ph.D.

THYROID (THERAPY)

X-ray Treatment of Exophthalmic Goiter. Charles S. D. Don. Brit. Med. Jour. April 28, 1934, No. 3825, 746-748.

The author discusses the x-ray treatment of exophthalmic goiter in a series of cases which have been under observation for a minimum period of one year. The results of this form of therapy were determined by a

study of the variation in the weight, the basal metabolic rate, the pulse rate, the patients' symptoms and signs and their own opinion as to the value of the treatment.

In the treatment of these cases two areas were treated at first twice a week, then once a week, and thereafter with increasing intervals between treatments as the patient improved. The following factors were employed: 6.5 inch spark gap, 3 milliamperes, 3 mm. aluminum filter, time, 5 minutes. With the apparatus employed, this exposure was equal to a half Sabouraud pastille dose. Rest and a nourishing diet were insisted upon but iodine was not prescribed.

The cases in this series were divided into "cure," "improvement," and "failure." Of the 103 patients beginning treatment, 10 discontinued it during the first three months and were treated by surgery. It was impossible, therefore, to classify these ten cases because of lack of sufficient time to determine the results of x-ray therapy. Of the remaining 93 cases at the end of six months' treatment seven had been operated on and at the end of a year six more had been referred for surgery. At the end of the two-year period seven additional patients were operated on and at the end of three years, one additional patient was treated by surgery. The author is of the opinion that these cases referred to surgery after the six-month period cannot all be classified as failures for a considerable number showed improvement. Of the seven patients referred for surgery after six months of x-ray therapy, four were classed as failures, and three were listed as improvement. Of the six operated on at the end of a year five were classified as failure and one as improvement. The final results are: Cure 38, improvement 30, failure 25.

While it was noted that recurrences and relapses may occur in those patients considered cured, it was also observed that the percentage of cures and improved cases was higher in a series of cases treated for more than one year than in a series treated for only one year. The author is of the opinion, therefore, that the extension of x-ray treatment beyond one year, when necessary, is justified as some cases do not reach their maximum improvement at the end of one year. The reported series is made up from the working classes and therefore it was the aim to obtain satisfactory results in one year. The author believes that this wish plus the low surgical mortality rate experience in his hospital probably accounts for the fact that a greater number of cases were operated on than Dr. Murray found necessary in his cases. Murray found surgical treatment advisable in about one twelfth of the cases of his series treated by the x-rays.

J. N. ANÉ, M.D.

Roentgen Therapy of Basedow's Disease. Franz Bardach. Strahlentherapie, 1934, 49, 618-633.

The author first reviews briefly the history of radiation therapy in Basedow's disease. It appears that small doses are advisable in the beginning in order to avoid severe reactions due to a sudden increase of

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THE RESEARCH TRAIL OF THE X-RAY¹

By A W CRANE, M D , *Kalamazoo, Michigan*

THE x-ray in the public mind is associated chiefly with hospitals, physicians' offices, and dental chairs. It is well known to have brought about revolutionary changes in the diagnosis and treatment of disease, and to have a place in the investigations and teaching of physics, but fewer know that the trail of research, which led down the centuries to the discovery of the x-ray, has a much wider interest and significance. As we follow it we find ourselves witnessing the early development of electricity, magnetism, and the vacuum. We are led as directly to the radio, and to other manifold applications of electricity *in vacuo*, as to the x-ray itself, and the continuation of this same trail after the discovery of the x-ray brings us to the astonishing study of radiations, to radium, to the demonstration of the electron and to those revelations of the structure of atoms which are altering so profoundly the older concepts of matter and energy.

A younger generation which has never lived in a world without x-ray and radio cannot hope to recapture that first wonder excited by these discoveries. But by retracing the winding, halting trail left by early experimentors, we will find a most fascinating story of exploration and discovery by pioneers in a world which lay

close about mankind, unknown and unsuspected until new eyes of science could be evolved to see by the light of the invisible spectrum. It is a story of the forging of new weapons against ignorance as indispensable to the advance of civilization as were the weapons of bronze that enabled man to escape from the Stone Age, a story of rare geniuses isolated from each other by long stretches of years, yet maintaining a continuity of science by the written record, and finally a curious story of the intermingling of error with insight, one no less important than the other, in forming the trail which led not only to the x-ray but also to the age of electricity in which we live.

I

The discovery of the x-ray then is seen to be an associated result of the observations and experiments of many predecessors who left a trail of investigations leading back to sources in electricity, magnetism, and the vacuum. We shall find that the first electrical experiments were with amber, that the first observations on magnetism were with the lodestone, and that the first permanent vacuum was formed in the barometer.

Before recorded history it was known that amber, when rubbed briskly, would attract or repel chaff, feathers, and similar light objects. Seldom has a fact so important seemed so trivial and lain under-

¹ Presented before the Radiological Society of North America at the American Congress of Radiology at Chicago Sept 25-30 1933

Irradiation to the Respiration and Glycolysis in the Tissues of Uterine Myoma^{1,2,3} Toyoshima Jap Jour Obstet and Gynec, December, 1933 16, 531-534

The author in his series of experiments on tissue respiration and glycolysis studied the effects of x ray irradiation on these functions of the tissues of uterine myoma. The mechanism of the favorable results obtained by irradiation therapy on uterine myomas has not been settled as some investigators believe that there is a direct action on the cells of the tumor and others are of the opinion that the action is indirect and results from disturbances produced in the ovarian tissues, which secondarily results in atrophy of the myomatous tissues.

The uterine myomas were removed by supravaginal amputation, were aseptically cut into pieces and then washed repeatedly with aseptic Ringer's isotonic solution containing sugar. The portions of tissue were then cut into halves and one half was irradiated and the other half served as the control non irradiated portion. The determination of the metabolism of these portions of tissue was obtained by means of the improved method of Warburg. The portions of tissue selected were irradiated immediately employing the following factors: Filtration, 2 mm Al and 0.5 mm Zn, time 28 minutes, minimum wave length, 0.076 Å, surface dose 310 r.

From the results of this experiment the author believes that the action of x rays on uterine myomatous tissue is direct. It was found that the metabolism generally increased immediately after the irradiation. After this period the metabolism gradually decreased. The respiration as determined by the author showed no change during the first six days after irradiation but

decreased after the seventh day when compared to non irradiated tissue. Anaerobic glycolysis was slightly greater in the case of the irradiated tissue during the first seven days but was found to gradually decrease after the seventh day. Aerobic glycolysis increased during the first seven days in the irradiated tissue when compared to normal tissue but the non irradiated tissue showed a more marked acceleration.

J N ANÉ, M D

Study on the Tissue Respiration and Glycolysis in Obstetrics and Gynecology, Part VI Effects of X ray Irradiation to the Respiration and Glycolysis in the Tissues of Uterine Cancer J Toyoshima Jap Jour Obstet and Gynec, December, 1933, 16, 534-537

The author studied the effects of x ray irradiation on the respiration and glycolysis of tissues of uterine cancer. The technic employed for the x ray irradiation and determination of tissue metabolism was similar to that used by the author in his work on the irradiation of uterine myomatous tissues.

These experiments showed that uterine cancer is more radiosensitive than uterine myoma. The metabolism of the tissues of uterine cancer was found to be increased and then afterward greatly inhibited following irradiation. Respiration increased after irradiation for the first three days then gradually decreased. Aerobic and anaerobic glycolysis in the irradiated cancer tissue demonstrated a marked increase for the first five or six days, then a rapid decrease in these functions was noted.

J N ANÉ M D

selves, have I addressed these magnetic principles in this new sort of philosophizing."

We see that Gilbert exemplifies in his own work the inductive method associated with the name of his contemporary, Francis Bacon. He also clearly anticipates Sir Isaac Newton in the matter of gravitation, explaining that ships and people do not fall off the planet because of the attraction of all bodies by the great mass of the earth. He states clearly that this is what is called weight and perceives that the same attraction is present in other celestial bodies. He says "So lunar things tend to the Moon, solar things to the Sun, within the orbs of their own effluvia."

One of Gilbert's most striking experiments was with his *terrella*, or earth-kin. The *terrella* was a large lodestone in the form of a ball to represent the earth. Every lodestone, whatever its form, has two poles, the same as any other magnet. A magnet made of a steel bar can be bent so as to bring the two poles near together, as in the case of the common horseshoe magnet. But in the form of a ball, the poles are necessarily opposite. Gilbert gave careful directions for ascertaining the location of these poles. The *terrella* was then supported at the poles so that it could be turned on an axis, like a library globe. A compass needle on the surface of this *terrella* would then point to the poles, no matter how the ball was turned, exactly as on the surface of the earth. When the needle approached a pole it would dip. This has been found to be the case with the earth, and by means of the dipping-needle the magnetic north pole has since been ascertained not to coincide with the axis of the earth. If Gilbert had known this he could have mounted his *terrella* to correspond. Nevertheless it remains to-day a marvelous demonstration, although not accepted as an explanation of gravitation.

It was Gilbert who first used the word "electrical," from the Greek for *amber*, to apply to properties of attraction arising from friction. He classified all bodies as

electric and non-electric. He little thought that his experiments with frictional electricity would outvalue his elaborate theories of magnetic gravitation. But he had supplied a method of investigation, a scientific recognition, a classification, and a name for phenomena which before his time were thought scarcely worthy of serious attention.

These phenomena happened to be the effects of high tension electricity, although in minute quantities, and this happened to be the form of electricity capable of exciting a vacuum—the one circumstance which determined the direction of the X-ray trail. Furthermore, this static electricity was the only form known until the discoveries of Galvani and the construction of the battery by Volta, in the closing days of the Eighteenth Century. But still static continued to be the only form of high tension electricity until some forty years later, when the co-discovery by Faraday and Henry of electromagnetic induction led to the invention of the coil, the dynamo, and the transformer.

An evaluation of facts is not to be expected of the pioneer investigator. Gilbert studied electricity because an electrical effect simulated magnetic attraction. He studied magnetic attraction because, to his mind, this simulated the attraction of the earth and other celestial bodies. He was inspired in his experiments not by simple facts but by a great astronomical theory, as was also von Guericke, who came after him. Indirection is an interesting characteristic of research and the neglected fact often is found later to lead to a treasure lying unsought and quite unsuspected. Never was this truth better exemplified than by Gilbert and his successors.

At this point, our research trail is recurrent, turning backward to the Thirteenth Century, to an ancient Latin manuscript on the magnet, from which Gilbert had borrowed freely. This is the famous "Letter of Peregrinus" (1269), first translated into English by Sylvanus P. Thompson, secretary of the Gilbert Society before

foot so long a time Amber, a fossil resin found chiefly on the shores of the Baltic, was a widely carried article of trade for at least two thousand years before the scientific investigation of its properties began. Although in a class with semi-precious stones, it was not especially rare. In fact, fifteen thousand pounds of it were brought into Rome during the reign of Nero. There was, therefore, no lack of opportunity to observe the amber phenomenon, yet this excited only idle curiosity in the great minds of antiquity. Finally it was the analogy of this strange power to that of the lodestone to attract iron which led to its first scientific study by Gilbert, only three hundred years ago.

A knowledge of the lodestone had to wait until iron was discovered and worked. Lodestone, an iron ore which is naturally magnetic, was widely distributed in the Mediterranean islands and adjacent lands. It is, in fact, a common ore found in many countries and is the source to-day of a large percentage of the world's iron. Certain masses of this ore were discovered to be especially magnetic and were highly valued in early times. One of the largest of historic interest, prepared by Galileo for the Duke of Tuscany, weighed five pounds, was able to lift four times its own weight, and was valued at four hundred crowns. Lodestones were puny playthings compared to the powerful electromagnets of the present day but, as natural means of stimulating early research, they were beyond price.

Dr. William Gilbert, physician to Queen Elizabeth, an enthusiastic convert to the Copernican hypothesis, conceived the idea that the earth and other heavenly bodies were huge magnets held in their orbits by the same attraction as that exhibited by the lodestone. To prove his theory he began experiments which soon carried him into unexplored regions. He was a busy practitioner in London and became president of the Royal College of Physicians, yet for a period of eighteen years he applied himself to this task, spending upon it a considerable portion of his income

without thought of pecuniary reward. But Elizabeth, although scornful of doctors even on her death-bed, remembered Doctor Gilbert with the only substantial bequest left to any of her personal attendants. The great Queen, fierce of will, with prophetic insight, gave to research a recognition which, though insignificant compared with modern endowments, still has power to stir our admiration.

In a lesser age Gilbert might not have been ignored so frequently by general historians, but his was the age of Shakespeare and Francis Bacon. It was the age when England was curbing the Spanish Empire in the New World and when the Invincible Armada was met and shattered. But while Hawkins and Drake were becoming great sea captains, and Raleigh was planting colonies in America, Gilbert in his laboratory was exploring another kind of a new world and definitely opening the trail that was to lead to the electrical development of the present day. His work may be said with truth to have contributed more to human progress than any of the picturesque exploits of his time.

"De Magnete" of Gilbert was a book famous even in his own day. That the appreciation of this work has grown with increasing knowledge, was shown by the formation of the Gilbert Society, with Lord Kelvin as its first president. This Society produced a translation of "De Magnete" from Latin into Elizabethan English, and revealed Gilbert as a vigorous writer quite able to fight his own battles, as may be seen from his preface. "Why should I, I say, add aught further to this so-perturbed republic of letters, and expose this noble philosophy which seems new and incredible by reason of many things hitherto unrevealed, to be damned and torn to pieces by the malediction of those who are either already sworn to the opinions of other men or are foolish corrupters of good arts, learned idiots, grammaticists, sophists, wranglers, and perverted little folks? But to you alone, true philosophers, honest men who seek knowledge, not from books only but from things them-

Von Guericke was a man of such political importance that his experiments could not but excite marked public interest. The King of Prussia was his friend and protector. One of his demonstrations before his royal patron was with the celebrated Magdeburg Hemispheres which he had devised. These were halves of a heavy metal sphere which would fit together so as to be air-tight, a stopcock enabling him to pump out the air. Heavy rings on each hemisphere could be attached to chains. An old print shows eight horses hitched to each hemisphere and being made to pull in opposite directions. The sixteen horses could not pull the hemispheres apart, yet, as soon as von Guericke turned the stopcock and let in the air, they fell apart of themselves.

Von Guericke recognized that air had weight and invented an air-balance. By measuring the weight of the atmosphere, but without knowledge of the Torricellian barometer, he was able to make extraordinary weather predictions and may be said to have founded the science of meteorology. He found that animals could not live in a vacuum and that all bodies, feathers and stones alike, fell with equal velocities therein. He made numerous other experiments which belong to the history of physics, but what interests us still further in the achievements of this remarkable man is his invention of the first electrical machine. This was a large ball of sulphur, supported on an axle, with a handle by which it could be rapidly turned. When the dry hand was held to the revolving ball, sparks were produced—a discovery of pivotal importance.

However, von Guericke's mind was pre-occupied by the theory of Copernicus. He found that the excited sulphur ball would attract all sorts of light objects, thus exhibiting a different and more universal attraction than the lodestone. It was, in effect, a non-magnetic terrella without poles. He arranged a tray beneath his sulphur sphere, on which he scattered bits of paper, shavings, particles of gold and

silver leaf, chaff, etc. When the ball was stroked with the dry hand and turned, these fragments were attracted and clung to the revolving globe, which to von Guericke simulated the attraction of the earth. He saw that this attraction was communicated over a linen thread a yard in length—really the first transmission of an electrical impulse over a conductor—though he did not perceive this to be an impulse or a current. He had produced a vacuum as a specimen of interstellar space, but it never occurred even to his fertile mind to excite it by sparks from his electrical machine. He little thought that these sparks which he drew from his electrified sulphur ball were to prove of greater importance than his fanciful demonstration of terrestrial gravitation. He had, indeed, illustrated his conception of the earth as a huge ball "rotated by the Hand of the Almighty and excited by the friction of the solar rays," but he was unmindful of the electric giant that so gently touched his hand. Here again a pioneer unknowingly trod the path to discovery with his eyes fixed on an *ignis fatuus*.

Like Peregrinus, von Guericke was a military engineer. In this capacity he had followed the fortunes of Gustavus Adolphus, the Lion of the North. He was a many-sided man, had studied law in Leipzig and other schools, and mathematics in Leyden. He had travelled extensively, and was a scholar with a strong bent toward science and philosophy. He returned to his native city of Magdeburg and shortly after, at the age of forty-four, became burgomaster, which position he held for thirty-five years. During this period he made his experiments and discoveries, the most original and important of his time, and composed his great work, "De Vacuo Spatio," in Latin. This was published in 1672 when von Guericke was seventy years of age, but an earlier account of his work, by Kaspar Schott, appeared in 1657 and inspired Boyle to experiments which made him the most celebrated English scientist of his time.

mentioned This letter (*Epistola ad Sigerum*) was written in the trenches while Peregrinus was engaged as a military engineer of the French army at the siege of Lucera, in southern Italy It was sent to his friend Sigerus de Fenicancourt, in his native town of Maricourt, France He begins "Dearest of Friends, At your earnest request, I will now make known to you, in an unpolished narrative, the undoubted though hidden virtue of the lodestone" Whereupon he launches into a treatise of 3,500 words, divided into chapters and avowedly intended to form a part of a larger work which, however, was either lost or never completed

Peregrinus gave an orderly arrangement of Thirteenth Century knowledge of magnetism and added new discoveries and inventions of his own, including the first compass to be pivoted and to be provided with a meridian scale, practically as we have it to-day Here we find the origin of Gilbert's terrella and also the description of the first magnetic motor ever proposed—the first far cry of the dynamo and the mechanical prophecy of an electric current

We had no further knowledge of Peregrinus until the astonishing works of Roger Bacon, his contemporary, were resurrected after an interment of over five hundred years Bacon, a courageous thinker and investigator, had been thrown into prison and his works suppressed by the Church In his "*Opus Tertium*," brought to light in 1859, Bacon calls Peregrinus one of the "two perfect mathematicians" of his day, and continues "He is a master of experiment Hence, he knows all natural science whether pertaining to medicine and alchemy, or to matters celestial and terrestrial He has worked diligently in the smelting of ores as also in the working of minerals, he is thoroughly acquainted with all sorts of arms and implements used in military service and in hunting, besides which he is skilled in agriculture and in the measurement of lands It is impossible to write a useful or correct treatise in experimental philoso-

phy without mentioning this man's name" It is all but obvious that Peregrinus had written larger works which were less fortunate than Bacon's in being resurrected However, the letter remained Manuscript copies were passed from scholar to scholar, twelve still being preserved in European libraries A later printed copy in the British Museum penciled by the famous (or infamous) Dr John Dee, "favorite astrologer" and confidential agent of Queen Elizabeth, proves that it was known to English scholars of Gilbert's time, although Gilbert does not mention it We see, in this letter of Peregrinus, the scientific source of the magnetic branch, which in "*De Magnete*," of Gilbert, joins with the electrical branch to form our research trail The third branch, that of the vacuum, is now to be traced

II

Contemporaneous with Gilbert was that mighty figure, Galileo, also a physician, who set in motion new intellectual currents by revolutionary discoveries in astronomy and experimental physics He had felt the heavy hand of the Church but in far-off Germany he influenced a man who was to take us a surprising distance on our journey This was the famous burgo-master of Magdeburg, Otto von Guericke, another ardent disciple of Copernicus, who began his work about forty years after Gilbert Although not an astronomer, he first predicted the periodic return of comets But what was of more practical importance, he reasoned that the earth, moon, and other heavenly bodies observed through the telescope of Galileo, must be moving in empty space, else the resistance of air would long since have brought all to a standstill Acting on this idea, he made the first air-pump in the world, for the distinct purpose of forming a vacuum so as to study celestial conditions close at hand Again, as is usual in research, his success was in unforeseen directions and led to unexpected conclusions

struments, later named by Boyle the barometer. However, it was the empty space above that was to prove the more important to our trail, because this was the first permanent vacuum, antedating von Guericke and his air-pump by about five years. Torricelli was too busy with his mathematical studies to publish his invention of the barometer, but described his experiments in two letters to his friend, Ricci, in Rome. In these letters, which are still preserved, he makes clear that his final purpose was "not simply to produce a vacuum but to make an instrument which shows the mutations of the air, now heavier and dense and now lighter and thin."

Research picks its devious way in unpredictable directions and without regard for the flight of time. Jean Picard, French priest and astronomer, forever famous as the savant who supplied Sir Isaac Newton with the calculations necessary to prove gravitation as a law of the universe, is also famous for an observation which must have seemed to him of trifling importance. One night, thirty-five years after Torricelli's experiment, Picard chanced to carry his barometer up some steps and noticed in the dark that the vacuum of the instrument became luminous. He found that he could produce the glow at will by agitating the mercury. As befitted a true scientist, he recorded this observation. A fact, once recorded, can bide its time. Twenty more years passed when Bernoulli, a German professor of mathematics, in reviewing some of Picard's calculations, came upon these notes on the barometer. He did some experimenting of his own by shaking mercury in tubes with and without a vacuum. He produced considerable light, which he called "mercurial phosphorus," and believed that he had invented a mechanical substitute for candles. The Picard glow, the strange light in the first vacuum, which in Bernoulli's hands became the unsuspected beginnings of the electric light, was destined henceforth to illuminate the research trail of the x-ray.

When the report of Bernoulli's experiments reached the Royal Society we are transported again to England, where Francis Hauksbee was beginning the investigation of "mercurial phosphorus." This was the subject of his first paper as Curator of Experiments. Instead of working with a miniature vacuum chamber in the end of the barometer, he exhausted much larger tubes and bell-jars by means of an air-pump of his own design. He finally demonstrated that the Picard glow, or Bernoulli's "mercurial phosphorus," was due to the friction of mercury on glass, which produced electricity.

Once started on this line of investigation, a limitless field opened before him. He made tubes within tubes so that either could be exhausted separately. He invented a small friction machine, the first of its kind, which he operated within an exhausted bell-jar. He built machines for the rapid rotation of vacuum bulbs six or eight inches in diameter and found that the friction of his dry hand on the outside of these globes gave the most brilliant luminescence. A quiescent vacuum tube lying near one excited, would glow without being touched. Finger-tips, held near, would emit a brush-like radiance. He thus discovered electrostatic induction, but offered no name or explanation. With delicate ingenuity, he operated one of his small machines inside a vacuum tube, so as to obtain the friction of woolen on amber without losing the vacuum. A vivid luminescence resulted. It was still far from the x-ray, but for the first time in the world, a vacuum tube, the ancestor of all x-ray tubes, was excited by an electrical machine.

A still more surprising forecast is to be related. This may be found in the first American book on electricity, now among the rarest in the collector's library. "'An Epitome of Electricity and Galvanism' By Two Gentlemen of Philadelphia, Printed by Jane Aitkin, No. 71, Philadelphia, 1809." In the historical preface is a paragraph that at once arrests the attention.

III

Robert Boyle, youngest son of the Duke of Cork, was the most highly gifted of a family noted for famous men, and spent a long and brilliant career devoted to physical experimentation, largely with the vacuum and with that mysterious property of attraction and repulsion which Gilbert named after amber. Although he made no step ahead on the trail of electricity, he advanced the study of the vacuum. Boyle deserves notice also as one of the founders of the English Royal Society, which was to play a major rôle in so many of the discoveries to be related.

This great Society granted a living to selected men who wished to devote their time to research and invention. The first of these "Curators of Experiment" was Robert Hooke, one of the most astonishing geniuses of any age. It now appears that a large number of the scientific discoveries and theories of the time of Boyle and Newton were the work of Hooke. His versatile mind took all science for its province. Thin, deformed, with an ugly temper, he became a misanthrope who saw his discoveries continually appropriated or misunderstood. He was a shrewd financier, and after his death an iron-bound chest was found in his lodgings, containing a fortune in gold and securities whereby he had hoped to found an institution for the development of his discoveries and inventions. However, having neglected to make legal provisions, his dream never came true. Nevertheless Hooke by method, apparatus, and discovery endowed the experimentalists who came after him, and his passing brings us to the most important figure in the early history of electrical exploration.

This figure is Francis Hauksbee, who followed Hooke as one of the Curators of Experiment to the Royal Society. Like Hooke, he combined inventive genius with exquisite mechanical skill, and an inquiring intelligence with that vein of originality necessary for scientific discovery. He had inherited, in a sense, the air-pump and the

vacuum which Boyle and Hooke had derived from von Guericke, and he proved to be a worthy successor to these pathfinders. While both von Guericke and Boyle had experimented with frictional electricity as developed by Gilbert, yet it remained for Francis Hauksbee to bring electricity and the vacuum together for the first time by intent and design. This achievement was the indispensable step, and the longest step, on the trail that led to the x-ray and its manifold results, to radio and world-wide communication, to incandescent and neon illumination, and to all the other multitudinous electrical inventions depending on vacuum tubes.

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struments, later named by Boyle the barometer. However, it was the empty space above that was to prove the more important to our trail, because this was the first permanent vacuum, antedating von Guericke and his air-pump by about five years. Torricelli was too busy with his mathematical studies to publish his invention of the barometer, but described his experiments in two letters to his friend, Ricci, in Rome. In these letters, which are still preserved, he makes clear that his final purpose was "not simply to produce a vacuum but to make an instrument which shows the mutations of the air, now heavier and dense and now lighter and thin."

Research picks its devious way in unpredictable directions and without regard for the flight of time. Jean Picard, French priest and astronomer, forever famous as the savant who supplied Sir Isaac Newton with the calculations necessary to prove gravitation as a law of the universe, is also famous for an observation which must have seemed to him of trifling importance. One night, thirty-five years after Torricelli's experiment, Picard chanced to carry his barometer up some steps and noticed in the dark that the vacuum of the instrument became luminous. He found that he could produce the glow at will by agitating the mercury. As befitted a true scientist, he recorded this observation. A fact, once recorded, can bide its time. Twenty more years passed when Bernoulli, a German professor of mathematics, in reviewing some of Picard's calculations, came upon these notes on the barometer. He did some experimenting of his own by shaking mercury in tubes with and without a vacuum. He produced considerable light, which he called "mercurial phosphorus," and believed that he had invented a mechanical substitute for candles. The Picard glow, the strange light in the first vacuum, which in Bernoulli's hands became the unsuspected beginnings of the electric light, was destined henceforth to illuminate the research trail of the x-ray.

When the report of Bernoulli's experiments reached the Royal Society we are transported again to England, where Francis Hauksbee was beginning the investigation of "mercurial phosphorus." This was the subject of his first paper as Curator of Experiments. Instead of working with a miniature vacuum chamber in the end of the barometer, he exhausted much larger tubes and bell-jars by means of an air-pump of his own design. He finally demonstrated that the Picard glow, or Bernoulli's "mercurial phosphorus," was due to the friction of mercury on glass, which produced electricity.

Once started on this line of investigation, a limitless field opened before him. He made tubes within tubes so that either could be exhausted separately. He invented a small friction machine, the first of its kind, which he operated within an exhausted bell-jar. He built machines for the rapid rotation of vacuum bulbs six or eight inches in diameter and found that the friction of his dry hand on the outside of these globes gave the most brilliant luminescence. A quiescent vacuum tube lying near one excited, would glow without being touched. Finger-tips, held near, would emit a brush-like radiance. He thus discovered electrostatic induction, but offered no name or explanation. With delicate ingenuity, he operated one of his small machines inside a vacuum tube, so as to obtain the friction of woolen on amber without losing the vacuum. A vivid luminescence resulted. It was still far from the x-ray, but for the first time in the world, a vacuum tube, the ancestor of all x-ray tubes, was excited by an electrical machine.

A still more surprising forecast is to be related. This may be found in the first American book on electricity, now among the rarest in the collector's library. "'An Epitome of Electricity and Galvanism' By Two Gentlemen of Philadelphia, Printed by Jane Aitkin, No 71, Philadelphia, 1809." In the historical preface is a paragraph that at once arrests the attention.

III

Robert Boyle, youngest son of the Duke of Cork, was the most highly gifted of a family noted for famous men, and spent a long and brilliant career devoted to physical experimentation, largely with the vacuum and with that mysterious property of attraction and repulsion which Gilbert named after amber. Although he made no step ahead on the trail of electricity, he advanced the study of the vacuum. Boyle deserves notice also as one of the founders of the English Royal Society, which was to play a major rôle in so many of the discoveries to be related.

This great Society granted a living to selected men who wished to devote their time to research and invention. The first of these "Curators of Experiment" was Robert Hooke, one of the most astonishing geniuses of any age. It now appears that a large number of the scientific discoveries and theories of the time of Boyle and Newton were the work of Hooke. His versatile mind took all science for its province. Thin, deformed, with an ugly temper, he became a misanthrope who saw his discoveries continually appropriated or misunderstood. He was a shrewd financier, and after his death an iron-bound chest was found in his lodgings, containing a fortune in gold and securities whereby he had hoped to found an institution for the development of his discoveries and inventions. However, having neglected to make legal provisions, his dream never came true. Nevertheless Hooke by method, apparatus, and discovery endowed the experimentalists who came after him, and his passing brings us to the most important figure in the early history of electrical exploration.

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might be put beyond dispute, by repeated and fully attested Trials Accordingly I was order'd to make an Instrument for the purpose " And before he has finished we are ready to concede that he was the best maker of scientific instruments in the England of his day and that his experiments settled this dispute for all time, as indeed they did

Francis Hauksbee was a part of the renaissance of English science and philosophy which reaches its height in the mighty works of Sir Isaac Newton The Royal Society had become the great protector and repository of the new learning In the year when Newton became its president (it proved for life), Hauksbee was elected a Fellow and read his first paper before the Society With this first paper he emerges from utter obscurity and, after a short scientific career of seven years, he disappears as utterly with his last His name is not listed in the encyclopedias The histories of the Royal Society are silent except for his scientific contributions There are no letters, no biography, no portrait, no hint of friend or family, except a single mention of a nephew In the English Dictionary of National Biography, we find a brief notice of his book only The date of his birth cannot be given and the date of his death, 1713, is fixed approximately by the posthumous publication of his last paper

IV

We who are born into this present age of electricity may well wonder why electrical development was so long delayed in the world's history Great civilizations flourished and decayed without bringing comprehension of this all-pervading force We may turn the pages of history, century after century, until we come to the time of Queen Elizabeth before we find the small beginnings of electrical science When we see Gilbert, von Guericke and the long line of their successors unaware of the opportunities that surrounded them, we may understand that

they had no idea of what we now naturally expect them to have been looking for As we trace electrical progress through still more centuries, it seems as if the trail lay through an interminable jungle where concealed facts, like a thousand unseen eyes, watched experimenters struggle along blindfolded and often backwards Although unsuspected and curiously hidden for the most part, electricity showed one primeval manifestation—lightning Yet lightning, a terrifying commonplace and the most amazing phenomenon in nature except the rising of the sun, nevertheless had to await Benjamin Franklin for an explanation

The conception of electricity which prevailed almost to the time of Franklin is hardly credible s'Gravesande, in his Natural Philosophy, a work of astonishing excellence and the recognized authority of its time, still contained in 1747 the following definition "Electricity is that Property of Bodies by which when they are heated by attrition they attract and repel light bodies at sensible distances"

The sparks resulting from friction were not regarded as electrical but as fire, which was believed to be inherent in all bodies Conservatism is perhaps a necessary refuge of authority It is now clear that long before the publication of this edition of s'Gravesande, Gray, in England, had made such a definition of electricity obsolete

Stephen Gray, seen in historical perspective, loses nothing of his interest and importance During the period of his discoveries he was a pensioner of the London Charterhouse, a combination of monastery, boys' school, and old men's home This is the Charterhouse immortalized by Thackeray's "Colonel Newcombe" To become a "poor-brother," one must be over fifty years of age and a member of the Church of England Such was Gray, who, in old age and poverty, was to gain an honored place among the great investigators who have brought forth knowledge indispensable to the progress of civilization

He appeared at intervals or sent papers

"He (Hauksbee) made many experiments to show the extreme subtlety of the electric light, and found out a method of rendering opaque bodies transparent. He lined with sealing-wax more than half the inside of a glass globe, and having exhausted it, put it in motion. On applying his hand to excite it, he saw the shape and figure of all parts of his hand distinctly and perfectly, on the concave superficies of the wax within."

Such a statement of what was apparently an anticipation of Roentgen by a hundred and ninety years, deserved investigation. It was found to be an abstract from the first "History of Electricity" ever written, an almost forgotten volume published in England in 1768, by Joseph Priestley, preacher, chemist, and discoverer of oxygen, whose printed works cover a most extraordinary range of subjects. Regarding the experiments whereby sealing-wax and pitch were rendered transparent, Priestley concludes, "They are really amazing and have not yet been pursued in the manner they deserve."

A recent repetition of those old experiments shows that the appearance to the eye is exactly as Hauksbee described. But, alas, the explanation as given in the light of modern physics is quite different from Hauksbee's, and attributes the transmitted image of the hand to electrostatic induction. However, as we continue on the research trail and later see x-rays produced years before their discovery, we may feel that these experiments of Hauksbee, had they not been forgotten, might have formed a fruitful working hypothesis instead of a prophetic error unmatched in the annals of science. Literally like Aladdin, he had rubbed his lamp and, in the luminous electrics of the vacuum, actual genii had appeared, obedient with powers such as Scheherezade in the "Arabian Nights" had not dared to imagine. But many years had yet to pass before a master should come to recognize them and find the magic formula of control.

In 1907 Hauksbee's numerous papers were published in a book dedicated to

Lord John Somers, Lord Chancellor of England, who retired from the presidency of the Royal Society in the year that Hauksbee was elected a Fellow. We catch a glimpse of contemporary England from the fact that Lord Somers was also a patron of "The Spectator" of Addison and Steele. The preface of his book opens with a sentence worthy of Francis Bacon: "The learned world is now generally convinced that instead of amusing themselves with Vain Hypotheses, which seem to differ little from Romances, there is no other way of Improving *Natural Philosophy* but by Demonstrations and Conclusions founded upon Experiments judiciously and accurately made."

It requires only a casual reading of this book to see that while his chief interest was in electricity, Hauksbee's range of investigation makes him an outstanding figure in the experimental physics of his day. He made original inquiries into many subjects, as, for example, the ascent of various fluids in small tubes and very narrow spaces, at a time when there were no terms such as "capillary attraction" or "surface tension" to be substituted for a real explanation. He seems to have been the first to suggest the possibility of liquefying air by pressure. He theorizes: "What kind of liquid would so many Atmospheres of condensed inelastic Air compose? Is it impossible that Air by this means should become a Visible Palpable Fluid, and be the subject to some of the same Management that other Fluids are?"

When the calculations of the Royal Society relative to the refractive indices of compressed air were disputed by the French Academy of Science, Hauksbee was ordered to make instruments of the utmost precision for confirmatory tests. That he executed this commission brilliantly we have his own account, faintly reminiscent of Benvenuto Cellini. He begins: "The Royal Society (whose Glory it is to be as unwilling to deceive as to be deceived) being inform'd that this Experiment was call'd into question by the French Academy, was desirous that it

made as well as those I may possibly make hereafter, since it is from his writings that I took the resolution of applying myself to this kind of experiment "

v

Following Dufay, electrical phenomena passed into a period of remarkable popularity. In Germany, Bose, later professor of physics at Wittenburg, was eager to repeat the French experiments, but having no money for apparatus, he cut off the nozzle of a large retort, in order to obtain a glass tube such as was used by Dufay. One day the globe which remained of the retort reminded him of Hauksbee's globes and rotating machine. He quickly found that no vacuum was needed—only friction on the rapidly revolving globe—to obtain a continuous supply of electricity. Bose's retort happened to be very large, and the quantity of electricity greatly exceeded any hitherto generated. Later, Hansen, of Leipzig, substituted a pad for the hand in making friction, and a truly efficient static machine was finally constructed, capable of unheard-of effects.

Still stronger machines, wire conductors, and insulators enabled experimentors to produce wonders without end, at unbelievable distances. Electrical research was no longer limited to two or three geniuses in a century. Public interest became insatiable. Electrical demonstrations supplanted the theater. Even in the lecture rooms of colleges, the populace crowded the students out of doors. The world was seeing, for the first time, artificial electric sparks, glowing brush discharges from the human body in darkened rooms, the ignition of spirits by fire from a piece of ice or a jet of water, the explosion of gunpowder at a distance, the electrocution of small animals, and innumerable other thrilling demonstrations that now would astonish only children.

Although there were not lacking serious students of this amazing force, yet little progress was made excepting in improved machinery until Dean Von Kleist, of the

Cathedral Camin, invented the Leyden jar so familiar in high school physics.

The vacuum in its relation to the electrical discharge seemed to have been forgotten by these investigators. The rapid development of electrical machinery and the use of conductors had opened new possibilities for the Hauksbee tubes. These opportunities were soon perceived by the Abbé Nollet, a former pupil and companion of Dufay in France, who was to prove a worthy successor to his brilliant friend.

The Abbé Nollet was not an ordained priest but an Abbé of the old régime, a courtier—gay, witty, handsome, a professor in the College of Navarre, and a tutor of the Dauphin. He would appear in his lecture room at Versailles in curled wig, laced-coat, and rapier half concealed by his rich black gown. There were few experiments or startling exhibitions of predecessors or contemporaries that he did not make more startling. He was a man of genius, notwithstanding, and as we follow his work we find ourselves again on the main research trail of the x-ray.

Hauksbee had excited his vacuum tubes by the attrition of his hand or by a little friction machine placed inside of his tubes. Abbé Nollet made his vacuum tubes with sealed-in wires and produced the Hauksbee effects by conductors attached to static machines. Nollet tubes were called, in his own day, "electric eggs"—a truly surprising appellation, for out of them, in all seriousness, hatched x-rays.

Abbé Nollet had actually assembled the essentials for the production of x-rays—the vacuum tube and an outside source of high tension electricity. A little higher vacuum and another wire sealed in the opposite end of his "electric egg"—and the x-ray would have been hatched then and there. But if x-rays had been produced at this time, no one could have known. The x-ray was practically invisible to the eye. That artificial retina, the photographic plate, was not evolved until ninety years later. The fluorescent screen, that step-down transformer of radiations, which could transmute invisible short

to the Royal Society. Five of his papers are preserved in the Philosophical Transactions. Gray's humble station was no bar to his entrance into the great Society which early in its career had been taught the democracy of science, curiously enough by a King, George III. The then new Society had rejected a John Graunt on the grounds that he was a tradesman. "His Majesty," with power to recall the charter, curtly disapproved and suggested that if the Society were so fortunate as to find any more tradesmen like Graunt, it should receive them forthwith. The Royal Society, worthy of its name and such traditions, finally bestowed upon Stephen Gray its first Copley Medal.

Gray carried out his experiments under the crudest of conditions, using twine, canes, sealing-wax, fish poles, glassware, wire, tea-kettle, stove poker and other household odds and ends, he acquired also glass tubes, silk thread, blocks of resin, and an old ivory ball. He discovered and established the greatest fact in electrical science, namely, that electricity is a current and will flow over conductors as well as remain a charge on the surface of glass or sulphur, as shown by Hauksbee and von Guericke. Gray's source of electricity was a glass tube or ivory ball excited by friction. He showed that electricity resides on the surfaces of bodies thus electrified, that conductors must be insulated, that insulators are not conductors, and, marvelously, that a charge is induced in a conductor closely parallel to a line carrying a current. In some of his experiments he suspended by cords boys of the Charterhouse, pupils of the "Gray Friars," and electrified them. These experiments were later repeated in France by Dufay and the Abbé Nollet, who were amazed to draw sparks of fire from the human body. Gray continued his researches with unabated zeal until his last illness and, on his death bed, tried to describe to his physician experiments which he saw he could not live to carry out. But he had done his self-imposed

work and pushed ahead the research trail for the next explorer.

Gray, like Hauksbee, is not listed in the encyclopedias. However, Gray's discoveries received unusual public attention during his lifetime because of a generous contemporary and rival in another land. Such is the magic of recognition beyond the boundaries of one's own country.

This rival was Charles Du Fay, who early studied Gray's papers and continued his lines of investigation. Dufay (as the name is usually written) made our research trail into an open path. He was in sharp contrast to Gray—a wealthy Frenchman, highly cultured, noted for wit and tact, a charming companion, and a man of surprising versatility. He had been an officer in the army and a diplomat before he became a member of the French Academy. After learning of Gray's experiments he devoted the remainder of his short life of forty-one years to electricity. It was he who overthrew the distinction between electrics and non-electrics which had obtained since Gilbert's *De Magnete*. He perfected Gray's method of insulation and showed that all bodies thus treated could be electrified. He amplified Gray's observations on the induction of currents. His greatest contribution was his discovery that resinous bodies and glass, when rubbed, yield different kinds of electricity, giving our first knowledge of what Benjamin Franklin rechristened as positive and negative electricity in his single-fluid theory.

Dufay deserves added fame for his generous recognition of Gray's work. It is difficult to recall, in the history of scientific discovery, a finer example of courtesy to a prior investigator than the remarkable acknowledgment, by this brilliant Frenchman, of the work of a "poor brother" of the London Charterhouse. On one occasion when he had prepared for the Royal Society an abstract of his papers before the French Academy, he sent it to the Duke of Richmond to be presented to Mr. Gray, "to whom I acknowledge myself indebted for the discoveries I have

Faraday's discoveries were multiform and again tempt us far afield. But for our purpose, it is sufficient to note his work on electro-magnetic induction of which he was the co-discoverer with Joseph Henry, secretary of the Smithsonian Institution. In the incredibly brief space of three months, Faraday alone had worked out the laws upon which depend, with hardly an exception, all the vast modern electrical industries—power, lighting, traction, telegraphy, and minor applications such as electro-typing and plating. He invented the dynamo and, in principle, with Henry, the first induction coil or transformer which was the general type of apparatus used by Crookes and Roentgen in their experiments, and still is used for the production of x-rays in all the laboratories and hospitals of the world.

It was Faraday's exquisite precision in the measurement of the quantity of electricity required to deposit a certain quantity of silver in the process of electroplating which first demonstrated that electricity existed in quanta or multiples of a unit of either energy or matter. Sir J. J. Thomson, in the Cavendish laboratory, in 1897, showed that the cathode ray in an x-ray tube is a stream of these electric quanta, or units, not of energy but of matter which could be deflected by a magnet. These were the electrons before mentioned, the "particles infinitely subtle" of Franklin, named by Johnston Stoney, weighed and measured by Millikan, and constituting in the aggregate the electric current. Thus did the x-ray lead directly to the discovery of the electron, which is the basis of our understanding of electricity and of the atom.

Much as his discovery stimulated research, it was rather by speculations of a highly theoretical nature that Faraday was destined, after his death, to start another pioneer on the trail of the x-ray. In the early part of his career he delivered a series of lectures on "The General Properties of Matter," and one of these bore the title "On Radiant Matter." He suggested that the luminosity of highly rare-

fied gases in a vacuum tube when excited by electricity was a property of matter in a fourth state. The three states, solid, liquid, and gaseous, were acknowledged realities, why not also a fourth state above the gaseous?

This hypothesis fascinated William Crookes, who, as a teacher of chemistry, was already a scientist of training and experience when he entered upon the line of experimentation which was to lead to the end of the trail. His memorable address before the British Association for the Advancement of Science in 1879 was on "Radiant Matter" and opened with a tribute to Faraday, who had inspired him. The subject was presented with a thoroughness and brilliancy that makes Crookes' papers classics in research.

Crookes used vacuum tubes in many different forms, original designs, containing various terminals and interior devices for demonstrating the properties of "radiant matter." In the long hiatus between the Abbé Nollet and Crookes, vacuum tubes had undergone modification at the hands of Geissler, Plucker, Hittorf, and others. Hauksbee's tubes were without leading-in wires, Nollet's tube had a single wire, and now the German tubes had two wires sealed-in, so that the electric current had to pass through the vacuum to complete the circuit. So ingeniously formed and so beautifully luminescent were the tubes of Heinrich Geissler, a glass blower of Tübingen, that the name "Geissler tubes" came to be a general designation for tubes of low vacuum.

But high vacuum tubes became known as "Crookes tubes." The induction coil supplied a controllable current. Crookes showed that as soon as matter entered into the fourth or "ultra gaseous state," entirely new phenomena were produced. These he studied in nearly every phase: the production of colors, their stratification, the dark spaces, the changes about cathode and anode, and the cathode ray. He showed that this luminous matter radiated in straight lines if the vacuum were

waves into longer waves which the eye could perceive, had not been found, although its precursor, the Bologna Stone, had been already the subject of idle investigation in the early part of the Seventeenth Century. So must one discovery wait upon another, and the conjunction of experiments wait upon the inspiration of genius—or a conspiracy of chance.

L'Abbé in many ways showed the scientific spirit. He carried out prolonged experiments to test the action of electricity on seeds, plants, and animals. He made a trip to Italy to investigate the new experiments of Galvani and Volta. He put forth an elaborate theory of electricity and gained a dominant reputation throughout Europe, but he was at his best at Versailles, surrounded by the elegance of the French court in the days of Louis the Sixteenth.

In the midst of this gay, brilliant, and highly sophisticated society, there was one man who held his own in wit, popularity, diplomacy, and scientific discovery. This was Benjamin Franklin. His electrical discoveries topped his already extraordinary reputation and made him easily the most famous man of his day. So manifold were his activities in so many fields that to describe a part of them is to leave a disturbing sense of incompleteness. His single fluid theory of electricity, in which he coined the terms "positive" and "negative" and in which he described electricity as composed of "particles infinitely subtle," has been substantiated by the discovery of the electron, and confirms him as a philosopher of the first rank. Abbé Nollet made an able and sarcastic attack on this theory in defense of his own, but Franklin, with genial wisdom, made no reply, stating that his theory would have to shift for itself. Franklin's name is identified with the electrical investigations of his period. The whole front was moved forward, the atmosphere of experimentation clarified, and the stage set for the next great actor.

VI

The public, always utilitarian, was soon asking, "What is the use of it all?" Franklin countered, "What is the use of a baby?" While medical quackery was answering the question in its own way, there was another one of those long pauses such as we have seen between Gilbert and von Guericke, or Hauksbee and the Abbé Nollet. It was a period of digestion during which minor experimenters were assimilating former discoveries that mark the general history of electricity rather than our research trail. Then came the genius who was to give the long-deferred answer to the question of electrical utility and, incidentally, to outfit the next explorers on the trail.

A young man of nineteen, an apprentice to a bookbinder, poor, with little education, but with a divine faculty of imagination, heard four lectures by Sir Humphrey Davy. He had already made some primary experiments in chemistry and constructed a static machine. The lectures fired him with the desire "to escape from trade which I thought vicious and selfish and to enter the service of science." Davy had the insight to recognize something unusual in this boy and made him his assistant in the Royal Institution, little dreaming that he was installing his successor. Thus was Michael Faraday, the incomparable experimenter, started on a career that was to alter civilization more profoundly than the wars of Napoleon.

The Royal Institution, where Davy and Faraday carried on their investigations, was founded by an American, Sir Benjamin Thompson, Count Rumford, thus strangely balancing the Smithsonian Institution in Washington, founded by an Englishman. Thompson, born two miles from the birthplace of Franklin, is a remarkable parallel to this other American Benjamin in the fertility and direction of his genius and in that mixture of business wisdom, diplomacy, inventive aptitude, and love of research.

distinguished as a president of the British Association for the Advancement of Science. Like Sir Isaac Newton, he was made president of the Royal Society and knighted by a queen. Like Gray, he was given a coveted Copley Medal. He received also the Order of Merit, and in 1907 was awarded the Nobel Prize in Chemistry. After all, these are pathetic substitutes for The Great Discovery. It is indeed a poignant tragedy of research that a great experimenter, an Argonaut of science, a worthy successor of his countrymen Gilbert, Hauksbee, Boyle, and Gray, should have been unaware of the Golden Fleece when finally it lay captured, but invisible, in his hands.

Although Crookes unknowingly produced x-rays, he was not the first. In 1785 Morgan, in London, experimented to find if electricity would pass through a perfect vacuum. He formed such a vacuum by boiling the mercury of a Torricellian barometer to expel all the gases. He demonstrated that electricity could not be forced through this vacuum. But in the course of one of the experiments the glass tube cracked so as to admit air very slowly. Morgan then saw a succession of colors beginning with yellowish-green and passing through blue and purple to red. He reported his observations to the Royal Society, suggesting that the degree of a vacuum could be determined by the resulting color of the electrical discharge. After Roentgen's discovery, the identification of the yellow-green shade with x-rays and a repetition of the experiment made it clear that Morgan was the first to produce them. It is also probable that, before the date of Crookes' publication, Julius Plucker and his pupil Hittorf, in Germany, working with high vacua, had unsuspectingly brought forth x-rays. In fact, Roentgen in his original announcement mentions his use of the Hittorf tube. But such were the extent, detail, and skill of Crookes' experiments and such the perfection of his lectures and papers, that the basic work leading to the discovery of the

x-rays remains rightfully associated with his name.

VII

As we retrace this long trail down the centuries, we find that it has been crossed and recrossed by various thinkers, not a few of great eminence and personal interest, who lingered or took a step or two on the pathway. Such were Sarpi, Cabaeus, Descartes, Pascal, Cavendish, and many others, especially since the time of Franklin. Galvani and Volta and the development of the battery, so essential to the early operation of the induction coil, have been passed by. But a few names that necessitate more than passing mention remain to occupy the space of eighteen years that elapsed after Crookes produced x-rays before Roentgen discovered them.

Our trail is unbroken from Faraday to Crookes and then to Roentgen. However, a branch trail of equal importance is seen approaching the x-ray over a wholly different route. This branch was opened by James Clerk Maxwell, who, like Crookes, was inspired by Faraday and his work. Unlike Faraday and Crookes, Maxwell was the scion of an aristocratic family and a finished product of universities. As a professor of physics at Cambridge while still very young, he became particularly noted for mathematical ability. Education had not spoiled him. His sense of humor, outcropping in his whimsical verses, suggests that there are two poles to the mathematical mind, as shown so well by another mathematician, Charles Dodgson, best known as Lewis Carroll, the author of "Alice in Wonderland." A certain quality of imagination is needed in creative mathematics as well as in other lines. Certainly it was by a creative genius that Maxwell interpreted Faraday's results in terms of higher mathematics, forming from them one of the most profound theories of any age, the Electromagnetic Theory of Light.

The fascination which this theory exercised over the great von Helmholtz, in Germany, is vividly recounted by Michael

sufficiently high, cast shadows of objects placed within the tubes, could be made to turn a delicate paddle wheel, and even melt refractory metals such as platinum. Within the tubes, diamonds, rubies, and various chemical compounds glowed with striking brilliancy.

Crookes papers were considered as perfect examples of pure science safely remote from possible utility. But pure science has ever been the path to discovery and invention. Crookes had raised his vacuum to the millionth of an atmosphere, which is within the limits of x-ray production. He noted the greenish-yellow color of the glass so familiar to workers with early x-ray tubes, and studied its spectrum. Unconsciously, unknowingly, he was generating x-rays—x-rays in more than sufficient quantity and penetration for practical diagnostic work. To quote from his first lecture "On Radiant Matter"

"This bulb is furnished with a negative pole in the form of a cup. The rays will, therefore, be projected to a focus on a piece of iridio-platinum supported in the center of the tube.

"I first turn on the induction coil slightly so as not to bring out its full power. The focus is now playing on the metal, raising it to white heat. I increase the intensity of the spark. The iridio-platinum glows with an almost insupportable brilliancy and at last melts."

This is a perfect description of an x-ray tube in full action, pushed finally to the point of destruction, as many an early roentgenologist was to know to his sorrow. As we turn the pages of Crookes' lectures and read the exhaustive investigation of every possible phenomenon within the tube, we can hardly believe that the next page will not describe what is taking place in the space outside. He found photographic plates out of freshly opened boxes strangely fogged and often blackened. No one could tell why. It is now obvious that this was due to x-rays passing through the paste-board boxes. Crookes tubes, and induction coils to run them, were added to the equipment of high schools and colleges

throughout the world. Many hundreds of trained workers operated and lectured upon Crookes tubes. Tubes varied, but a majority must have produced x-rays, yet no one discovered them.

In one of his lectures Crookes seems knowingly to be dealing with an outside ray. He refers to the "molecular" or "emissive" ray from his tube which can be seen only when a screen is interposed in its path, beyond the tube and compares it to a small beam of light in a dark room which becomes visible only when it strikes upon a cardboard. He does not tell us the composition of his screen. Keen, tireless, resourceful, a genius of the first rank, nevertheless, he remained oblivious to the one most important phase of his life-study—the penetration of opaque bodies by his "emissive ray."

If Crookes had studied Francis Hauksbee he would have gone to the source of the idea and of the term "radiant matter," and would have been reminded of the possibility of the penetration of opaque material by emanations of a vacuum tube made luminous by electricity. Hauksbee says "Here's a figure transmitted through the most dense and compact part of an opaque Body, with the same facility and advantage to the Eye that it would through those which would seem the most easily pervious to the radiant Matter which is to form the Representation."

The papers of Hauksbee and Crookes lie together in the Philosophical Transactions of the Royal Society, to supplant each other historically and to arouse meditations on the elusive ways of research.

Sir William Crookes was the son of a London tailor. He was self-taught for the most part and as a boy experimented in a little laboratory of his own making. He devoured books after the manner of youthful genius. He never attended a university, and, like Franklin Faraday, and Edison, his originality was never restricted by the educational mould. He became a teacher but never held a professorship. Nevertheless, he received the highest recognition for his work, he was

x-ray On March 10, 1897, was published "Further Observations on the Properties of the X-rays," his second and final paper on the subject of this epoch-making discovery

Roentgen's actual discovery was made November 8, 1895 A false story of the discovery, describing the accidental image of a key developed on a photographic plate, obtained a wide circulation in America, and is still quoted The true story is given by Sylvanus P Thompson in his address as president of the newly formed London Roentgen Society in 1897 We are assured that Roentgen had set up his apparatus for the distinct purpose of investigating possible emanations from a Crookes or Hittorf tube He was acquainted with the work of Lenard but was not at the time using a tube with an aluminum window He had covered a Crookes tube with black paper and excluded all the light from the room He had, lying on a table nearby, a piece of cardboard coated with platino-barium-cyanide, known to be sensitively fluorescent to Lenard's rays He turned on the electric current to excite the tube and saw the coated cardboard brightly luminous With the precision of a trained investigator he found the tube to be the source of invisible emanations which could penetrate cardboard or a book of a thousand pages or the flesh of the hand

He did not at first know that this fluorescence was not due to some species of Lenard's cathode rays that were able to pass through the glass wall of the tube as well as an aluminum window In his original paper, after giving experiments to settle this point, he says "I therefore come to the conclusion that the x-rays are not identical with the cathode rays but that they are generated by the cathode rays at the glass wall of the discharge apparatus"

From the day of the discovery to the day when he handed in his first communication, he gave himself unremittingly to experiments with this new emanation, often eating and sleeping in his laboratory His wife, Bertha, was his only con-

fidante Even his assistant, who pumped his tubes, knew nothing of the discovery until after its publication Alone he discovered the x-rays and alone he proved that they were different from every other kind of radiation hitherto recognized and described

Honors were piled upon him He declined the proffered "von," the sign of nobility He was unchangeably modest and shrank from public notice Notwithstanding many alluring invitations from institutions of learning, he held to his professorship at Wurtzburg until, in 1900, the Bavarian Government, which had conferred upon him the "Verdienst Orden" of the Crown, virtually commanded him to accept a call to the University of Munich In 1909 he received the Nobel Prize At the height of the World War he returned the honors which he had received from various foreign governments, including the Order of the Italian Crown and the Rumford Medal of the English Royal Society

Roentgen was descended on his father's side from an ancient Rhenish merchant family His mother came of good Dutch stock whose forebears had emigrated from Italy in the Seventeenth Century He was an only child, born in Lennep, a small city on the Rhine, where he passed a happy childhood He was more fond of the outdoors than of books and later in life delighted in mountain climbing He was not at first distinguished as a student and was once expelled from his academy after steadfastly refusing to give the names of his associates in a harmless prank He failed to pass the examinations for admittance to the University It is apparent that this was due to indifference rather than any lack of ability Later when he came under the influence of August Kundt, a professor of experimental physics, an enthusiasm and a purpose were aroused that determined his career His reputation grew with the publication of many research papers He advanced steadily, attaining one position after another until he was made a professor of physics in the

Pupin in his autobiography, "From Immigrant to Inventor" Von Helmholtz extended this theory in his own Dispersion Theory of the Spectrum in which he provided a space for γ -rays and for radio waves, specifying their properties, including their power to pass through opaque material, years before either was known or named—a feat of intellect probably never surpassed. It was this theory of von Helmholtz' that led two famous English physicists, Sir Oliver Lodge and Sir J. J. Thomson, to the opinion, only eight months after Roentgen's discovery but over fifteen years before it was experimentally proven, that the γ -rays belonged to the short wave end of the light spectrum.

Von Helmholtz was the mathematical discoverer of the γ -rays before their physical discovery by Roentgen, just as Leverrier was the mathematical discoverer of Neptune and Lowell of Pluto, before the telescopic demonstration of these planets was accomplished by Galle and Tombough.

Von Helmholtz was more than a theorizer, he set his pupil, Henrich Hertz, to the task of producing some of these electromagnetic waves in his laboratory. This Hertz accomplished in 1888. These waves, henceforth to be known to physicists as Hertzian waves, are the wireless or radio waves which, as few of the millions who use them daily realize, are the outcome of a learned mathematical theory.

Von Helmholtz, great research teacher that he was, had set other students at work in other directions to find other electromagnetic waves. The electrically excited vacuum bulb was suspected to be a possible source of such waves. A glass-blower, Muller, later a famous maker of γ -ray tubes, was put to the task of supplying experimental bulbs. One of von Helmholtz' students, Eugen Goldstein, studied the colored stream which was visible between the terminals in these tubes when a current was passing, and named it the cathode ray. This ray, noticed previously by Plucker and Hittorf, was the cathode ray which engaged so much the attention of Sir William Crookes. Some fifteen

years had passed when Philippe Lenard, another student of von Helmholtz and later of Hertz, again took up the investigation of the cathode ray, with results which justified the far-seeing initiative of the great teacher.

Hertz had shown that the cathode rays or stream would pass through a sheet of aluminum placed within the tube. Lenard made a tube with an aluminum window sealed in the glass wall of the bulb where the cathode rays were focussed. The stream passed through this window into air for a distance of about three inches. This distance has been greatly exceeded recently by W. D. Coolidge, who repeated Lenard's experiment, using heavy currents of high voltages, and who showed that the cathode ray is still a fertile subject of research. Lenard identified his cathode ray by the phosphorescence of minerals placed in its path and by the deflection produced by a magnet. He also placed photographic plates in the path, securely enveloped in light-proof holders. The opaque holders were penetrated. Images were obtained of dense bodies placed on the plate-holders. Lenard did not know that the cathode rays, after passing through the aluminum window, were mixed with an abundance of another kind of ray. Unconsciously he was making " γ -ray pictures." Was ever a great discovery so often and so closely approached, so long overdue, and hidden by so thin a veil?

VIII

While Lenard was still busy with his investigation, looking through the veil darkly, Wilhelm Konrad Roentgen made his historic announcement. December 28, 1895, he handed to the president of the Wurtzburg Physico-medical Society, a paper, "On a New Kind of Ray." Almost overnight it became world-news. Because of Christmas holidays, it was a month later when Roentgen delivered before the Society the deferred address on his "Arbeit." Excepting class lectures, this was his first and last public address on the

ULCERATIONS OF THE STOMACH AND SMALL INTESTINE FOLLOWING ROENTGEN THERAPY¹

REPORT OF A FATAL CASE, WITH PERFORATION

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THE possibility of damaging the gastro-intestinal tract by deep roentgen irradiation was first brought out in 1912 by Regaud, Nogier, and Lacassagne.² Describing the effects of irradiation in dogs they noted especially gastric atrophy and intestinal ulceration, with and without perforation. Important contributions to this aspect of the problem have been made by Warren and Whipple,³ and by Martin and Rogers.⁴

Clinical records of ulceration of the gastro-intestinal tract in man following deep x-ray irradiations have been contributed by Kroemer,⁵ Franz,⁶ Heck,⁷ Fischer,⁸ Bécélère,⁹ Mathias,¹⁰ Ball,¹¹ Case and Warthun,¹² and Seigmund.¹³

We desire to place on record the following case of multiple ulcerations of the stomach and bowel which terminated fatally by perforation.

R. B., a salesman, 48 years of age, was admitted to St Luke's Hospital on March 18, 1929, having been referred by Dr. A. J. Goodwin, of Kankakee, Illinois. It appeared from his history that during the preceding September he had noticed a small tumor mass in the left axilla. This under-

went a slow increase in size until it was removed in November, 1928. It consisted of several lymph nodes, the largest of them measuring about 4 cm in diameter. On section, they showed the characteristic architecture of Hodgkin's granuloma. The blood Wassermann was fully negative at that time. The blood count was erythrocytes, 4,020,000, hemoglobin, 90 per cent, and leukocytes, 13,800, with polymorphonuclear neutrophils, 84, large mononuclears, 2, and lymphocytes, 14. There was no complaint of cough, dyspnea, or chest pains, and no development of sensori-motor disturbances. His urine was normal. Except for sciatica five years previous, and a small hydrocele, his past medical history was without incident. Within a few weeks glandular hyperplasia had reappeared about the original site in the left axilla and about January 1, 1929, he began to experience discomfort and pain after eating and was much troubled by accumulation of gas in the stomach. These symptoms grew progressively worse until, at the time of admission, they recurred after each time he took food, depending in severity and duration on the amount eaten. Despite these discomforts, he had a good appetite and continued his normal food habits. The nights were usually fairly comfortable and he was entirely free from pain in the morning. He had never vomited and he did not require cathartics. He had never noticed tarry stools. He had maintained his normal weight and endurance. An x-ray fluoroscopy of the gastro-intestinal tract, using barium, failed to reveal any evidence of gastric or duodenal ulcer. Chest roentgenography failed to reveal any adenopathy that might be due to Hodgkin's disease. There was a good deal of hypertrophic osteo-arthritis involving the dorsal spine.

¹ Read before the American Congress of Radiology, at Chicago Sept 25-30, 1933

² Arch d'electric med, Oct 10, 1912

³ Jour Exp Med 1922 35, 187

⁴ Am Jour Roentgenol and Rad Ther, 1924 2, 280

⁵ Monatschr f Geburtsh u Gynak 1917, 46, 292

⁶ Berlin klin Wehnschr 1917 27, 663

⁷ Strahlentherapie 1920, 798

⁸ Strahlentherapie 1921-1922, 332

⁹ Presse med, Nov 23 1921

¹⁰ Centralbl f allg Path u path Anat, 1921-1923 33, 65

¹¹ Am Jour Roentgenol and Rad Ther 1925 13, 220

¹² Am Jour Roentgenol and Rad Ther 1924 12, 27

¹³ Handb d Spez path Anat u Histol Berlin 1929 4, Part 3 337

strict old University of Wurtzburg which once had refused to accept him as a student. Here in later life, in the security and serenity of an academic career, with an established reputation, he accomplished his great "Arbeit," in defiance of those conditions which so often bring on a sterility of genius. Such was his patriotism that, in the extremities of the War, he turned over his worldly possessions to his country. He was childless, the last of his line, and the death of his devoted Bertha left him peculiarly alone. Four years later, in 1923, at the age of seventy-eight, he died of cancer, in great poverty, under the roof of a friend. His final resting place is at Giessen, where as a young professor he spent the happiest years of his life.

One of Roentgen's memorials is the finely executed statue on the Potsdam Bridge, showing him, Jove-like, seated and gazing with brooding eyes at a vacuum tube held in one hand. Many other investigators had gazed long and earnestly on this fateful tube and had carried the torch of research down the centuries—but the secret remained a secret. The eye had to see beyond the tube. The flash of the fluorescent screen had to be answered by a flash of supreme genius. So priceless is the gift of scientific intuition and so difficult the discovery of a new fact, that unconditional admiration is due the man who first recognized these long-hidden rays and who first saw shadows made by invisible light.

IX

Our research trail continues until the α -rays have been traced and identified as part of the spectrum. This revelation

did not come for fifteen years after Roentgen's discovery. No one had been able to reflect or refract α -rays and thus prove their relation to light. Finally Professor Max Laue, of Munich, reasoned that if the wave lengths of the rays were sufficiently short, then ordinary mirrors would be to them what a pebbly road-surface would be to ordinary light. He proposed the use of the cleavage plane of a crystal so as to secure rows of atoms which would provide the smoothest surface in nature and the closest possible grating for the production of an α -ray spectrum, if these rays were of the order of visible light. Although the actual experiment was made by Knipping and Friedrich, at Freiburg, the achievement is universally accredited to Laue. A more brilliant example of deductive reasoning is hard to find. The prediction was verified in every particular, the rays were located at the ultra-violet end of the spectrum, and the designation X, an unknown quantity, became henceforth a matter of history. This work with the tiniest of cosmic bodies, the bending of unseen radiations by the unseeable structure of crystals, is indeed a fairy-tale of science in which the real treasure was found to have been hidden all the time in the far end of the rainbow.

We have come to the end of the trail only to find that this is a fresh starting-point for advances in many directions. Thus it must be with every discovery, so long as the human mind thirsts after knowledge. If the future is to repeat the past, then succeeding generations will look back on Millikan and his confrères, not as completing the conquest of that last frontier of the spectrum, the cosmic rays, but as opening a trail to frontiers yet unseen.

date a complete barium fluoroscopy was carried out, reported by Dr Alfred M Houston as follows

"Lungs and heart show no roentgen evidence of pathology on screen observation. Esophagus of usual size, position, and contour. The stomach is fishhook in type, medium sized, with usual tone and peristalsis. The wall seems normally flexible and no filling defects in contour noted. The stomach is empty in six hours, with head of the barium meal in cecum. The pylorus functions normally. The caput is large and fills to regular contour under pressure. The second portion of the duodenum is somewhat dilated but shows the usual course. The terminal and transverse portions of the duodenum show considerable dilatation and appear to be firmly fixed across the middle of a tumor mass palpable in the upper abdomen. There is marked 'rocking' of duodenal contents. No definite roentgen evidence of pathology is noted in the rest of the small bowel. The terminal ileum is visualized at six hours. The transverse colon can be moved freely over the abdominal tumor mass. The splenic and descending colons are apparently normal. The impression gained from the examination is that the tumor mass is probably retroperitoneal."



Fig 2 Photograph illustrating the ulcers in the lining of the small bowel, encircling the lumen excepting a short segment on the antimesenteric side

Our patient received a total of 2,180 r units, covering a period of nine months, from March 18 to December 12, 1929. There were nine sessions of therapy, usually consisting of one area to the anterior abdomen and one to the posterior abdomen. At no sitting did we give over 320 r to any one area. On two occasions we gave a total of 640 r through two portals. He received his last x-ray treatment on December 12, 1929, on which date we administered 320 r units.

His blood count January 15 was red cells, 3,160,000, leukocytes, 4,400, hemoglobin, 65 per cent, neutrophils, 40 per cent, eosinophils, 20 per cent, lymphocytes, 40 per cent. Since his last x-ray treatment, he had felt weak and complained of generalized aching, especially severe across the abdomen, and decline of appetite. The temperature had not been elevated. There were no cutaneous lesions. On February 3 his temperature was 98.8, pulse 78, and the abdomen somewhat tympanic. The spleen was not demon-

strably enlarged. In the right lower quadrant was a firm, irregular mass, easily felt through the thin abdominal wall. It was not tender and gave the impression of hard feces in the cecum.

He was hospitalized February 3, 1930. Under observation, distinct periodicity was apparent in the occurrence of the abdominal pain. It showed immediate increase after eating and lasted from one to three hours. There was a good deal of intestinal flatulence. There were no other symptoms with the exception of a slight

Upon examination a generalized adenopathy became apparent, palpable lymph nodes in the inguinal, axillary, cervical, and supratrochlear regions being present, and deep abdominal palpation revealed a

determine the existence or otherwise of mediastinal gland involvement showed normal root shadows and the posterior mediastinum to be clear. Besides a fair amount of infiltration involving the smaller



Fig 1 Photograph illustrating the huge spontaneously perforated ulcer in the cardiac portion of the stomach. Note the small ulcers in the mucosa along the margin of the large lesion.

marked enlargement of the mesentery lymph nodes. The spleen was enlarged to the costal margin. The liver was not palpable. In the mid-epigastrium, from about two inches below the xiphoid to the umbilicus, was a mass about as large as a grapefruit of somewhat nodular form and smooth in consistency, not tender and very slightly movable either to manipulation or on respiration. This was judged to be due to an agglomeration of enlarged glands. The tonsils were atrophic and the mouth showed a chronic gingivitis. The blood count revealed: red cells, 4,360,000, leukocytes, 8,550, hemoglobin, 85 per cent, differential—neutrophils, 78 per cent, eosinophils, 2 per cent, lymphocytes, 20 per cent.

An x-ray examination of the thorax to

bronchi of both lungs and an area of what appeared to be scar tissue in the right lower lobe, the lungs appeared to be free of pathology. The diaphragm was regular on both sides except for a slight flattening on the left.

The patient was given a series of x-ray therapeutic treatments consisting of four exposures on successive days. There was no disagreeable reaction. He left the hospital with condition unchanged.

On April 15, 1929, he was re-examined. His body weight remained unchanged. His abdominal discomforts, which had disappeared for a period, were again in evidence. The spleen could not be felt but the abdominal glands were still palpably enlarged although smaller than formerly. No other adenopathy existed. About this

thoracic portion of the esophagus was unchanged. The cavum of the stomach contained a large dark red blood clot. On the posterior surface of the cardia was a huge circinate ulcer of the lining that reached to the greater curvature. It extended 9 cm in the longitudinal axis of the stomach, and 12 cm in the transverse. The flat black granular floor was depressed 6 mm below the overhanging and undermined edges. On the greater curvature, just beyond this huge ulcer, was another, a punched-out defect, 2 cm in diameter, and proximally was a third one almost as large. Along the edges of the large ulcer were several more, much smaller in size. The hilum of the spleen was opposite the proximal margin of the large ulcer. There were no ulcers or other changes in the duodenum. In the lumen of the duodenum was a fluid stained red with blood. The small and large bowels were opened lengthwise along their mesenteric attachment. Much of the jejunum had the usual circular folds, but in the ileum were dark gray and green ulcerations, rough and warty, as wide as 2 cm, and encircling the lumen as much as 5 or 6 centimeters. They were arranged toward the side of the mesenteric attachment, and on the side away from the mesentery was an interval of bowel lining of from 5 to 10 millimeters. The distal ulcer was 90 cm from the cecum, others were distributed proximally above the first at intervals of from 20, 33, 8, 3, 230, and 38 centimeters. The oval Peyer's patches, from 1.5 to 2.5 cm in diameter, were stippled with black. The lumen of the small bowel contained a large quantity of fluid stained with blood. There were no ulcers or other changes in the lining of the colon and rectum.

There was considerable fibrous tissue between the aorta and the lumbar vertebrae and about the inferior vena cava below the level of the renal vessels. Just above the right renal vein was a soft, gray lymph node 2.4 cm in diameter. In the fibrous tissues about the left renal vein were small masses of lymph node tissues. The right and left

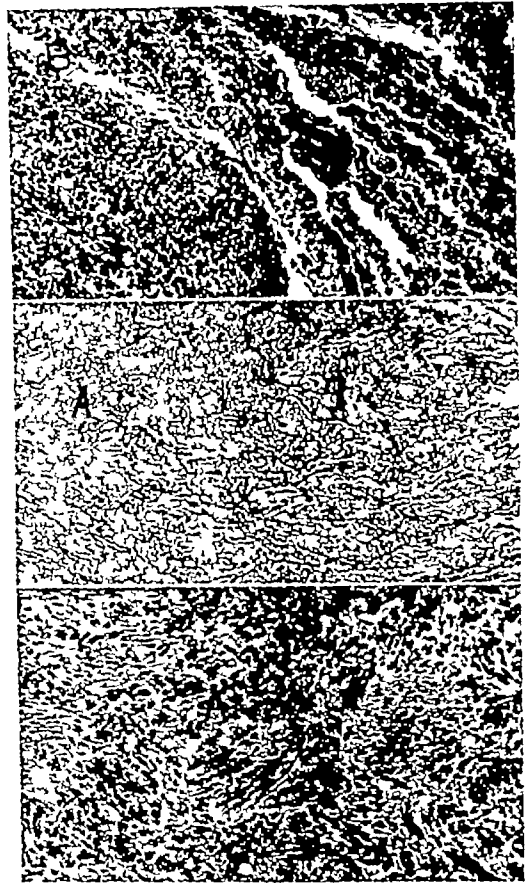


Fig 3 *Upper* Photomicrograph illustrating the undermined margin of the large ulcer of the stomach. A fold of gastric mucosa (A) overhangs the edge and the base (B) is chronic granulation tissues. There is no resemblance of these tissues to those in the lesions of lymphogranulomatosis.

Fig 4 *Center* Photomicrograph of the edematous collagenous connective tissues (A) in the submucosa. These changes extended for a considerable distance around the margin of the huge ulcer of the stomach. Comparable changes occur with roentgen ray burns of the subcutaneous tissues.

Fig 5 *Lower* Photomicrograph of the granulation tissues (A) about the ulcers of the small bowel.

groin lymph nodes were not enlarged, the axillary was but moderately enlarged.

Hemolytic streptococci were identified by cultures of the peritoneal exudates. The routine examination of the other tissues of the trunk demonstrated no noteworthy changes.

Anatomic Diagnosis—There were the following findings in the anatomic diagnosis: huge perforated ulcer and multiple small ulcers of the membranous lining of

shortness of breath on exertion and a sense of fullness in the epigastrium. There had been very little complaint regarding pain until February 1, three days before admission, although preceding that date, and for a period of about two weeks, there had been present a dull ache on both sides of the abdomen, more especially on the left. It became much more severe on the date named and was punctuated by acute exacerbations, referred to the epigastrium and to the infra-costal region, especially after the taking of food. It was to some little extent influenced by posture, being relieved somewhat by the patient's turning on either side. Abdominal examination demonstrated a mass about 3 cm below the umbilicus, to the left of the one described. These masses were not freely movable and were not tender to palpation. The liver margin could not be palpated and the spleen was not demonstrably enlarged. It was observed that the patient's rectal temperature showed a slight afternoon elevation. On the fourth day, following admission, without preceding chill, the body temperature suddenly increased to 104.6. From this high peak, there was a gradual decline until the rectal temperature reached normal in about four days.

On February 13 there occurred a sharp chill, with an increase of temperature to 104, and it remained persistently high thereafter until death. Neither physical nor x-ray examination could demonstrate any pathology of the lung.

The patient complained of severe pain in the back about the twelfth dorsal segment, radiating into the upper abdomen. In consequence of this, he had had a poor night's rest. On abdominal examination there was a vague indication of a slight amount of free fluid in the abdomen. Neither the spleen nor the liver was enlarged. The chest was clear. The eosinophil count was 4 per cent.

On February 14 the abdomen appeared swollen and somewhat rigid and there was undoubtedly free fluid in the peritoneal sac. On the preceding day he had had a sharp chill followed by a rise in tempera-

ture. It was apparent that the patient had a general peritonitis. Surgical consultation with Dr S W McArthur was followed by immediate exploratory laparotomy. A mid-line incision was made. On opening the peritoneal cavity, a milky, greenish fluid in considerable quantity was found and the peritoneal surfaces were covered with a good deal of fibrinous exudate. The appendix was isolated and found to be retroperitoneal and retrocecal. It was reddened and swollen. No other definite local pathology being demonstrable, the abdomen was closed with drainage.

The patient died on February 19.

Necropsy —The essential features of the post-mortem examination (Edwin F Hirsch), which was limited to the trunk, are as follows. There was a recently repaired surgical incised wound in the mid-line of the abdomen. On the surfaces of the peritoneum, there was a generalized fibrinous exudate. The appendix vermiformis had recently been removed, the amputation stump was tied off and covered with peritoneum so that the fecal material did not escape. The spleen weighed 115 grams. Fibrous adhesions, between the anterior and posterior walls of the lesser peritoneal space, markedly shortened the lateral extent of this space. In exploring these adhesions between the posterior wall of the stomach and the pancreas, an encapsulated perforation of the stomach wall was encountered and from this a quantity of bright red blood escaped. The greater curvature of the moderately distended stomach extended 10.5 cm below the tip of the xiphoid in the midline, the lesser curvature, 3.5 centimeters. In the fat tissues between the greater curvature of the stomach and the transverse colon, there were several white, flat, opaque lymph nodes as large as 1 cm in diameter. The distal portion of the transverse colon was bound in the adhesions on the posterior surface of the stomach. The lymph nodes in the root of the mesentery were firm, opaque, white tissues as large as 2 cm in diameter, the biliary lymph nodes were as large as 2.5 centimeters. The lining of the

thoracic portion of the esophagus was unchanged. The cavum of the stomach contained a large dark red blood clot. On the posterior surface of the cardia was a huge circinate ulcer of the lining that reached to the greater curvature. It extended 9 cm in the longitudinal axis of the stomach, and 12 cm in the transverse. The flat black granular floor was depressed 6 mm below the overhanging and undermined edges. On the greater curvature, just beyond this huge ulcer, was another, a punched-out defect, 2 cm in diameter, and proximally was a third one almost as large. Along the edges of the large ulcer were several more, much smaller in size. The hilum of the spleen was opposite the proximal margin of the large ulcer. There were no ulcers or other changes in the duodenum. In the lumen of the duodenum was a fluid stained red with blood. The small and large bowels were opened lengthwise along their mesenteric attachment. Much of the jejunum had the usual circular folds, but in the ileum were dark gray and green ulcerations, rough and warty, as wide as 2 cm, and encircling the lumen as much as 5 or 6 centimeters. They were arranged toward the side of the mesenteric attachment, and on the side away from the mesentery was an interval of bowel lining of from 5 to 10 millimeters. The distal ulcer was 90 cm from the cecum, others were distributed proximally above the first at intervals of from 20, 33, 8, 3, 230, and 38 centimeters. The oval Peyer's patches, from 1.5 to 2.5 cm in diameter, were stippled with black. The lumen of the small bowel contained a large quantity of fluid stained with blood. There were no ulcers or other changes in the lining of the colon and rectum.

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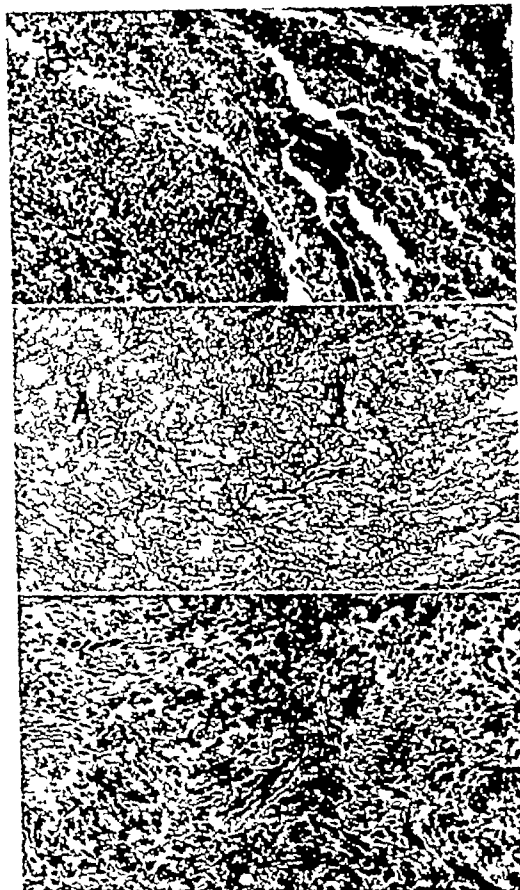


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Anatomic Diagnosis—There were the following findings in the anatomic diagnosis: huge perforated ulcer and multiple small ulcers of the membranous lining of

the stomach, annular cicatricial ulcers (eight in all) of the lining of the small bowel, acute generalized scro-fibrinous peritonitis, bilateral fibrinous pleuritis, huge recent hemorrhage into the lumen of the stomach, recent hemorrhages of the lungs, hyperplasia of the spleen, parabronchial, mesenteric and biliary lymph nodes, marked fatty changes of the liver, cloudy swelling of the myocardium, liver, and kidneys, etc

Histology—Tissues from the edge of the huge ulcer of the stomach were examined in histologic preparations. The mucosa, tunica propria, and tissues as deep as the muscularis ended abruptly at the edge of the ulcer and formed an overhanging edge. The stomach wall beneath the ulcer and to the subperitoneal fat was cellular chronic granulation and scar tissues of variable thickness, in some places scarcely 1 millimeter. Along the edge toward the lumen was a narrow margin of necrotic tissue and exudate with markedly diminished staining qualities, and in the surface of this was a leukocytic exudate. The cells of the granulation tissues were held in a hyaline stroma of coarse threads, some of which probably were remnants of the original tissues of the wall. These cells were chiefly small lymphocytes and large monocytes, a few were polymorphonuclear leukocytes. Only small bundles of smooth muscle remained. A noteworthy histologic change was the marked widening of the submucosa for a considerable distance about the ulcer margins by edematous hyaline fibrous tissue with very few nuclei. Wide collarettes of dense hyaline fibrous tissue surrounded the large blood vessels in these places.

The ulcers of the small bowel were edematous mucosa, markedly infiltrated with lymphocytes and polymorphonuclear leukocytes. Along the lumen was a margin of necrotic tissue covered with a fibrinous exudate. Much of the lining epithelium had been destroyed and in the crypts between the villi were the basal portions of tubules lined by a columnar epithelium. The muscularis was infiltrated with round cells and polymorphonuclear leukocytes.

The parabronchial lymph nodes had many large mononuclear cells, not a few with carbon pigment, some with brown blood pigment. The stroma was edematous, and in the meshes of the reticulum fibers were lymphocytes, plasma cells, a few neutrophilic and eosinophilic leukocytes, and an occasional small multinucleated giant cell. Narrow collars of hyaline connective tissue surrounded the small blood vessels. There were only slight connective tissue changes in the spleen. Large portions of the left renal lymph node tissues were necrotic. The intact tissues consisted mainly of compact small and large lymphocytes in an edematous reticulum. The pattern of structure in the necrotic portions was faintly retained and where these merged into the non-necrotic portions there was a margin of variable width composed of large mononuclear phagocytes, polymorphonuclear leukocytes, and pyknotic or fragmented cell nuclei. There was a slight granulation tissue reaction.

A periaortic abdominal lymph node had large and small irregular lobed masses of dense hyaline material. Some were acellular coarse masses of collagenous connective tissue, many others had slender crevices with elongated and compressed fibroblastic cells, lymphocytes, or plasma cells. The interstices between the hyaline masses had a cellular fibroblastic stroma with many plasma cells and small lymphocytes. There were no appreciable numbers of eosinophilic or neutrophilic leukocytes. Many of the medium-sized arteries had the usual muscular media, narrow intima, and a broad hyaline fibrous adventitia. Other blood vessels of this caliber had thick hyaline walls and a narrow endothelial lining. Another lymph node nearby had a few hyaline masses and changes comparable only in a general way to those of lymphogranulomatosis.

The visceral changes demonstrated by the post-mortem examination and histologic studies consist, in brief, of the following: a single huge perforated ulcer and multiple smaller ulcers of the stomach,

multiple (8) circumscribed annular ulcers of the small bowel (ileum), necrosis and hyaline scar tissue changes of the perirenal and mesenteric lymph nodes. The gross and microscopic examinations of the parabranchial, biliary, mesenteric, and perirenal lymph nodes disclosed tissue structures that had only the slightest resemblance to lymphogranulomatosis, and the spleen had no indubitable changes of that disease. The evidence of an active lymphogranulomatosis accordingly dwindles to a small quantum.

Considerations directed toward establishing a causal factor for the multiple foci of necrosis take into regard the anatomic conditions of the lesions respectively in the stomach, the small bowel, and the lymph nodes. It is reasonable to believe that the necrosing agent is common for all, and a further basis for this conclusion rests upon similarity of tissue alterations in each.

Although the published reports of gastrointestinal damage by deep roentgen therapy are few, certain ones on record describe conditions comparable to those found in this patient. The indictment of the roentgen therapy as the noxious agent has in support these published reports, although due regard is taken of the many therapeutic treatments given in which no serious damage has been demonstrated, at least by anatomic studies.

It may be proposed, in discussion of the foregoing interpretation of the findings described, that these lesions represent spontaneous ulceration of lymphogranulomatosis tissues in the gastro-intestinal tract. It is well known that no organ of the body is exempt from involvement in lymphogranulomatosis. Cases have been reported showing apparently isolated primary involvement of skin, mamma, kidney, uterus, iris, conjunctiva, tonsil, dura, lung, bone, intestine, and stomach. While the early manifestations are usually glandular these may escape detection because of their obscurity, and the disease process appears to be confined to a single locality such as the intestine or stomach. Stein-

del¹⁴ was the first to describe a case of Hodgkin's disease (lymphogranulomatosis) strictly confined to the stomach. A number of cases, six in all, have appeared in the literature since Steindel's report. These are described and discussed by Singer,¹⁵ who adds a case of his own. All of these cases came to light only after a histologic examination of the material removed at operation. The pre-operative diagnosis had been either peptic ulcer or carcinoma of the stomach. The literature of reported cases indicates that a diagnosis is seldom if ever made until the surgeon makes an exploratory laparotomy and even then the correct diagnosis is determined by the pathologist.

A Grevillius¹⁶ describes two forms of lymphogranulomatous involvement occurring in the gastro-intestinal tract. The first resembles tuberculous ulceration with a necrotic surface and elevated edges, these ulcers having a tendency to spread. They do not cause any change in the mesentery glands. The other kind shows limited tumor formation based on a granulation infiltration emanating from the submucosa and built up of fibroblasts, plasma cells, Sternberg giant cells, eosinophils, and lymphoid cells. These tumors indurate and indent the wall of the stomach or gut involving the mesenteric lymph nodes, and give a typical picture of lymphogranuloma.

It is conceivable that if the gastro-intestinal wall be infiltrated and ulceration is pending or has developed, irradiation might have the effect of causing necrosis or hastening the process of softening in such radiosensitive tissue so that the effect of x-ray might be to increase and extend the ulcerative process. On theoretical grounds it may be assumed that this is more apt to happen in intestinal lesions than in gastric. Ivy, McCarthy, and Orndoff¹⁷ apparently proved that the bowel mucosa

¹⁴ Arch f klin Chir, April, 1924, 130, 110

¹⁵ Arch Surg 1931, 22, 1001

¹⁶ Lympho granulomatosis i Tarm Kanalen Svenska L  kartidningen, 1931, 28, 1105

¹⁷ Jour Am Med Assn, 83, 1977

is approximately twice as sensitive to x-ray as the mucosa of the fundal portion of the stomach. As compared with the normal skin, experimental evidence seems to indicate that the normal stomach is twice as resistant to the harmful effects of radiation. The question arises whether or not extensive ulceration of the mucosa of the normal stomach could be produced by any method of x-ray therapeutic cross-fire without concurrent extensive injury to the skin and subcutaneous tissues.

It is well known that most glandular conditions are quite radiosensitive and it might not be unreasonable to believe that lymphogranulomatous infiltration in the stomach or bowel might break down following irradiation. Granting this possibility, the fact remains that many hundreds of patients with Hodgkin's disease have been treated over the abdomen with considerably larger doses than the case herewith reported without serious results following. Over a period of years of treating a great many patients for all types of deep-seated lesions we have never before seen a perforation of a hollow viscus occur. We have given very large doses to patients affected with abdominal Hodgkin's disease with no untoward results. In one such case a total of 9,270 r was given covering a period of three years, and except for a diarrhea which was easily controlled no unfavorable symptoms developed. Another patient who had Hodgkin's disease with abdominal adenopathy was treated still more extensively over a period of three years, so that the skin was very dark and scaly and a marked hypoplastic anemia supervened requiring many transfusions, yet there were no gastro-intestinal symptoms of importance and at autopsy no ulcerations of the stomach or bowel were found. Although clinical considerations do not encourage the belief that x-ray necrosis of deep-seated organs can be in any degree common, the fact that they may occur is established by experimental research on animals and by the few apparently au-

thentic cases reported in the literature. The following considerations lead us to the conclusion that the case herewith reported may constitute such an instance.

(1) The dearth of gross and histologic characteristics of gastric lymphogranulomatosis, especially the absence of a marked thickening of the stomach wall.

(2) The huge extent of the large ulcer and the multiple smaller ulcers.

(3) The undermined character of the ulcer margins.

(4) The marked edema and hyaline changes of the submucosa without appreciable cellular exudates.

(5) The perivascular fibrous changes.

The most careful scrutiny of section from the concomitant multiple ulcers of the small bowel failed to reveal the presence of indubitable lymphogranulomatosis tissues. The entire absence of hyperplastic changes in the agminated follicles of lymphoid tissue (Peyer's patches), and also the lack of any thickening of the bowel wall away from the immediate vicinity of the ulcers, together with the absence of hyperplasia of regional mesenteric lymph nodes, are facts that appear to possess special significance.

SUMMARY

Tissue necrosis resulting in ulcerations of the hollow viscera may follow deep roentgen therapy applied to the abdominal region. Such effects have been produced experimentally in dogs, and in a few instances have been recorded in the literature as occurring clinically in man. There is herewith reported with clinical and pathologic detail a case of multiple ulcerations of the stomach and small bowel following deep x-ray irradiation. Death resulted from perforation of a huge ulceration on the posterior wall of the stomach.

We gratefully acknowledge the very helpful co-operation of Dr. Edwin F. Hirsch, pathologist, St. Luke's Hospital, Chicago.

THE RESULTS OF POST-OPERATIVE X-RAY THERAPY IN CARCINOMA OF THE OVARY

A SERIES OF TWENTY-TWO CASES¹

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From the Gynecologic Service of Dr Brooke M Anspach and the X-ray Service of Dr Willis F Manges, Jefferson Medical College Hospital

DURING the past several years numerous reports have appeared in the literature concerning the efficacy of roentgen therapy in the treatment of carcinoma of the ovary. Beginning with von Franque (1), who, in 1912, reported temporary improvement in a girl of 16 with ovarian cancer with metastasis, many authors have reported series, the most recent having been reported by Wintz (2). An accurate comparison of results reported by the different observers is impossible because of a lack of uniformity in the listing of data which influence response to any form of cancer therapy. We believe the following facts should always be recorded: the histologic diagnosis, grade of malignancy, degree of operability, and the radiation factors. Of these, the first three can always be grouped in patients treated post-operatively. Comparison of the radiation factors may not be possible in a small series of patients because of the varying clinical response and post-operative course. It may be impossible, because of the patient's condition, to give the maximum amount of radiation deemed necessary, or the patient may be removed from the hospital before adequate radiation has been given. However, the factors employed should be recorded so that statistics suitable for analysis and comparison may be accumulated.

This study is based on the results obtained in a series of patients, 22 in number, who were treated on the gynecologic service of Professor Brooke M Anspach and the x-ray service of Professor Willis F Manges at the Jefferson Hospital between 1924 and 1933.

¹ Presented by title before the American Congress of Radiology, Chicago, September, 1933.

HISTOLOGIC DIAGNOSIS

All patients were operated upon and the diagnosis proved by histologic examination of tissue removed. The following histologic types were diagnosed: adenocarcinoma, four cases, papillary adenocarcinoma, three cases, papillary cystadenocarcinoma, fourteen cases, granulosa-cell carcinoma, one case. The first two types occurred as solid or semi-solid tumors of moderate size. The papillary cystadenocarcinomas were usually large serous or pseudomucinous cysts, in which carcinoma had developed. The single granulosa-cell carcinoma was found in a moderately large tumor with multiple cystic cavities.

GRADE OF MALIGNANCY

Following the suggestion of H C Taylor, Jr, the cases have been divided into three histologic grades of malignancy. The grading of each tissue was done by one of us (J B M) with the assistance of Dr Baxter L Crawford, Pathologist to the Jefferson Hospital, who had made most of the original histologic studies. The grading was based upon the degree of anaplasia as indicated by the extent of cell differentiation, variation in size and shape of the cells, and nuclear changes. Each tumor was graded on the basis of the histologic picture alone, no consideration was given in any case to the clinical course.

Low Grade Malignancy, or Grade I, includes those tumors in which well differentiated columnar epithelium lined the glands and cysts, the adult structure being maintained throughout except in occasional areas where the cells infiltrated the stroma.

or formed numerous layers within the glands

Intermediate Grade Malignancy, or Grade II, includes those tumors in which the columnar epithelium was not so well differentiated, the individual cells presenting variations in size and shape, and moderate nuclear changes, with more extensive infiltration and the frequent formation of solid areas. Glandular and papillary structures were poorly developed and distorted.

High Grade Malignancy, or Grade III, includes those tumors in which undifferentiated epithelial cells with marked nuclear changes developed in strands or solid areas. There was little evidence of glandular or papillary structure.

CLINICAL CLASSIFICATION

Once a tumor has been definitely diagnosed as carcinoma, the extent of the growth is the important clinical factor influencing the prognosis. Recent authors have taken cognizance of this and classified their cases so as to differentiate between early, far advanced, and hopeless cases. Keene, Pancoast, and Pendergrass (3) considered two groups. Group I consisted of widespread carcinoma in which only a laparotomy could be done, Group II included all cases in which a complete or partial operation was possible. Ford (4) reported results in three clinical groups, unilateral, bilateral, and inoperable. Heyman (5) studied the cases treated at the Radiumhemmet as radically operable, incompletely operable, recurrent, and inoperable. Others have used somewhat similar classifications.

We have adopted the following clinical classification, based upon Schmitz's method of classifying carcinoma of the cervix.

Group I—Ovarian carcinoma without extension or involvement of surrounding or adjacent parts, completely operable. This group consists of unilateral ovarian tumors which are not adherent.

Group II—Ovarian carcinoma with extension or involvement of surrounding or

adjacent parts, completely operable. In this group are placed completely removable bilateral carcinomas, completely removable carcinomas which are adherent, completely removable carcinomas with extension, and Group I cysts ruptured during operation.

Group III—Ovarian carcinoma with extension or involvement of surrounding or adjacent parts, incompletely operable. This group includes all cases in which a partial operation can be done.

Group IV—Ovarian carcinoma with extension or involvement of surrounding or adjacent parts or with metastasis at a distance, inoperable cases in which only a laparotomy and biopsy can be done.

Group V—Ovarian carcinoma, recurrent, inoperable. The terminal stage of all except those cured.

IRRADIATION

Irradiation was usually begun from two to four weeks after operation, two methods being used. Prior to August, 1927, massive doses were given in a single sitting, at right-angles to one of three or four pelvic ports. The amount given was that which the skin would tolerate, and the entire course was completed in three or four days. The factors were 3 milliamperes at 170 to 200 kilovolts, filtered through 0.5 millimeter of copper and 1.0 millimeter of aluminum, at 50 centimeters skin-target distance, through ports 16, 19, or 20 centimeters square. An erythema was obtained with 270 milliamperes-minutes of treatment.

After August, 1927, treatment was given after the saturation method of Pfahler (6). Usually four ports were used, though occasionally, in thin persons, only three. The patients were measured and a diagram of the pelvis made by the procedures devised by Weatherwax (7) employing Desjardins' (8) charts. Effective depth dosage was measured in international roentgens and a graphic chart kept to show from day to day the amount of radiation received. All patients after January, 1925, received treatment with the following fac-

tors 20 or 30 milliamperes, 175 to 200 kilovolts, filtered through 0.5 millimeter of copper and 1.0 millimeter of aluminum at 50 centimeters skin-target distance, through ports 16, 19, or 20 centimeters square. The central ray was directed obliquely into the pelvis. The erythema value from January, 1925, to August, 1930, was 970 r, and since August, 1930, has been 800 r, in terms of milliampereminutes the erythema ranged from 320 to 610 milliampereminutes as determined by the efficiency of the tubes employed and the voltage at which they could be operated.

In all instances an effort was made to give the maximum amount of radiation which the skin, pelvic structures, and general condition of the patient would permit. No attention was paid to the histologic type of the tumor, its grade of malignancy, or degree of operability in determining the amount to be administered, because experience with tumors in other areas had shown that these factors could not be used as criteria for the determination of the amount of radiation required.

Patients were treated on alternate days. Each day treatment was given, enough x-ray was administered through each of the four pelvic ports, so that at the end of four weeks the effective depth dose was from 1,600 to 2,000 r. The general condition of the patient sometimes would not permit this. In stout patients these doses could not always be delivered into the depths because of the danger of damaging the skin. Slender patients permitted of the ready administration of the maximum depth dose.

Radium has been used in association with roentgen irradiation in treatment of these tumors. This is notably true of the patients reported from the Radiumhemmet by Heyman (9 and 10) and by Ford from the Mayo Clinic (4). Radium was not used routinely by us, only three patients in the series having received radium applications, in two, 2,400 milligram-hours were applied through the intra-uterine route, and in the other the radium was applied directly through the abdominal inci-

sion into the tumor mass. It is obviously impossible to draw conclusions from these three patients.

Diarrhea was not uncommon, it was not often accompanied by other symptoms. Abdominal pain or tenderness were only rarely associated with irritability of the bowel developing during irradiation. The diarrhea usually disappeared promptly on cessation of the treatment, in fact, it often stopped if treatment were postponed for one day. While diarrhea as evidence of colitis should be taken into account, it is not an indication for stopping treatment. It cannot be doubted that it is due to irradiation, because it is seen most frequently in thin persons who receive the greatest depth doses.

RESULTS

Histologic Type of Tumor—The papillary cystadenocarcinoma was the type most frequently encountered. Of the 22 patients, 14 had this variety, nine were serous, and five pseudomucinous. Seven are alive, six dead, and one untraced. Four of the living had serous tumors and three had pseudomucinous. Four patients with serous tumors and two with pseudomucinous died, the one untraced patient had a pseudomucinous growth.

Four of the five patients living for more than five years had papillary cystadenocarcinoma, three were of Grade I malignancy, the other of Grade III. These patients represent 80 per cent of the five-year cures.

Adenocarcinoma was the next most frequent, four patients having this type and they are all dead. Three of them had incompletely operable tumors, two of Grade II malignancy, and one of Grade III. One adenocarcinoma of Grade II malignancy was wholly inoperable.

Papillary adenocarcinoma was encountered in three patients, one with an incompletely operable Grade III tumor is alive almost two years after operation, with part of the tumor still present. Two patients with this variety are dead. Both had wholly inoperable tumors, one with a

Grade III tumor died three months after operation, the other, with a Grade II tumor, died one year post-operatively

The one patient with a granulosa-cell carcinoma is the fifth in the group of patients cured for five years. This tumor was of Grade I malignancy.

Grade of Malignancy—Tumors of Grade I malignancy were the most frequently encountered. Of ten cases of this Grade, seven are alive, two have died, and one is

untraced. The average duration of life to date in those who have survived is 38 months, of the two who died the average duration was 6.5 months.

Five patients, all of whom have died, had tumors of Grade II malignancy. Three of them, incompletely operable, had an average post-operative duration of 14 months, in two, with wholly inoperable tumors, the duration of life averaged slightly less than five months.

TABLE I—COMPLETELY OPERABLE GROWTHS, WITHOUT EXTENSION

Patient No	Age	Type ²	Grade ³	Courses	Total Irradiation		Result
					Skin r	Depth r	
1 T M	29	PCA	I	Oct 10–Oct. 25, 1928	1,740		Untraced
2 E L	23	PCA	I	July 17–July 24, 1929	1,740	2,280	Living and well, 4 yrs, 6 mos, post-operatively
3 T C	61	PCA	I	Nov. 29–Dec. 23, 1929	2,000	2,800	Died, 1 yr post-operatively
4 C P	47	PCA	I	Sept. 29–Oct. 21, 1931	1,200	1,680	Died, 1 mo, post-operative ulcerative colitis
5 A M	60	PCA	I	Oct. 10–Nov. 14, 1931	1,360	1,360	Living and well, 2 yrs, 2 mos, post-operatively

² PCA = Papillary cystadenocarcinoma

³ I = Low grade malignancy

TABLE II—COMPLETELY OPERABLE GROWTHS, WITH EXTENSION

Patient No	Age	Type ⁴	Grade ⁵	Courses	Total Irradiation		Result
					Skin r	Depth r	
6 H R	57	PCA	III	June 26–June 30, 1926	1,280	1,280	Living and well 7 yrs 5 mos, post-operatively
7 M P	40	PCA	I	Aug. 4–Aug. 12, 1927	1,350	1,350	Living and well 6 yrs 5 mos, post-operatively
8 M A	35	PCA	I	Aug. 16–Aug. 26, 1927	1,740	2,440	Living and well 6 yrs, 6 mos post-operatively

⁴ PCA = Papillary cystadenocarcinoma

⁵ I = Low grade malignancy, III = High grade malignancy

TABLE III—INCOMPLETELY OPERABLE GROWTHS, WITH EXTENSION

Patient No	Age	Type ⁶	Grade ⁷	Courses	Total Irradiation		Result
					Skin r	Depth r	
9 M Y	32	PCA	I	Jan. 29–Feb. 2, 1924	1,450	1,300	Living and well, 10 yrs, post-operatively
10 F C	48	GCC	I	June 13–Aug. 9, 1932	1,040	940	Living, 7 yrs, 1 mo, post-operatively
				Dec. 7 to Dec. 16, 1926	1,840	1,840	
				May 5–May 13, 1927	1,840	1,840	
				April 14–May 12, 1931	1,480	1,480	
11 E F	60	PA	III	Feb. 21–March 2, 1932	1,200	1,200	Died 1 yr 6 mos post-operatively
				Jan. 28–April 16, 1928	1,840	2,300	
				Nov. 12–Nov. 25, 1929	730	900	
12 L C	56	AC	II	Jan. 9–Jan. 22, 1930	2,000	1,800	Died 3 yrs 8 mos
				May 26–June 20, 1930	2,200	2,000	
13 M D	32	PCA	I	March 1–March 26, 1930	2,300	2,100	Living, 3 yrs 10 mos post-operatively
				Jan. 25–Feb. 17, 1933	900	810	
14 M M	44	PCA	II	Feb. 5–Feb. 11, 1931	480	480	Died 2 mos post-operatively
15 J A	38	AC	III	Jan. 7–Feb. 3, 1932	1,440	1,440	Died 4 mos
16 M H	41	PCA	II	Jan. 21–Feb. 12, 1932	960	1,350	Died 3 mos
17 A M	48	PA	III	Feb. 18–March 11, 1932	1,040	1,250	Living 1 yr 10 mos

⁶ AC = Adenocarcinoma PA = Papillary adenocarcinoma PCA = Papillary cystadenocarcinoma, GCC = Granulosa-cell carcinoma

⁷ I = Low grade malignancy II = Medium grade malignancy, III = High grade malignancy

Of the seven patients with Grade III tumors, six are dead and one is living for more than six years, in the latter, the tumor was completely operable. Three of those who died had incompletely operable tumors, and in three the tumors were wholly inoperable.

Degree of Operability—Five patients had completely operable tumors (Table I), all large cysts of low grade malignancy. Two patients with a pseudomucinous type of cyst are alive, one four years and six months, the other two years and two months post-operatively. Two with serous tumors died, both in less than one year. One patient with a pseudomucinous tumor is untraced.

Three patients with completely operable tumors with extension (Table II) are alive more than six years after operation, all of them had papillary cystadenocarcinoma, one with a serous tumor of Grade III malignancy, two with Grade I tumors, one of which was serous and the other pseudomucinous.

Nine patients had only partially removable tumors (Table III). Four of them are alive in three, the tumor was Grade I, in two, serous papillarycystadenocarcinoma, and in the third, a granulosa-cell tumor. The fourth patient in this

group had a Grade III papillary adenocarcinoma. Five patients are dead—in three the tumor was Grade II, in two Grade III.

Five patients with wholly inoperable tumors are dead (Table IV), all in less than one year. Two were of Grade II and three of Grade III malignancy. One patient had an adenocarcinoma, two had papillary adenocarcinoma, and two had papillary cystadenocarcinoma of the serous type.

Amount of Irradiation (Table V)—It is difficult to compare the amount of radiation administered to the various patients, first, because of the smallness of the series, and secondly, because of the great variation in their clinical conditions. In some, the disease was so far advanced that death occurred shortly after operation. In others, the course outlined was not completed because of some intervening difficulty. Records have been kept of the radiation given and outlined in terms of r units (Table V). In two, the depth dose was not known, one of these patients died and the other is untraced. Of the nine surviving patients, four received from 100 to 1,500 r, three from 200 to 2,500 r, and two, more than 2,500 r. Of the eleven who are dead and in whom the dose was

TABLE IV—INOPERABLE GROWTHS, WITH EXTENSION

Patient No	Age	Type ^a	Grade ^a	Courses	Total Irradiation Skin r Depth r		Result
18 B S	42	PCA	III	Feb 6-Feb 10 1924	800		Died 4 mos post-operatively
19 N C	46	AC	II	Aug 9-Aug 15 1927	450	540	Died 3 mos post-operatively
20 M L	54	PA	III	Aug 25-Sept 17 1927	1 550	930	Died 3 mos, post operatively
21 A S	38	PA	II	July 10-Aug 1, 1928	1,840	1 840	Died 1 yr, post operatively
22 H F	35	PCA	III	Nov 30-Dec 19 1928	1,160	1,600	Died 7 mos post-operatively

^a AC = Adenocarcinoma PA = Papillary adenocarcinoma, PCA = Papillary cystadenocarcinoma

^a I = Low grade malignancy, II = Medium grade malignancy, III = High grade malignancy

TABLE V—ROENTGEN THERAPY IN CARCINOMA OF THE OVARY AMOUNT OF IRRADIATION, DEPTH DOSE, r UNITS

	Living					Dead					Untraced	
	1,000-1 500 r	1 500-2,000 r	2,000-2 500 r	2,500 r plus	Less than 500 r	500-1 000 r	1 000-1 500 r	1,500-2 000 r	2 000-2,500 r	2,500 r plus	Amount unknown	Amount unknown
Group 1	1											
Group 2	2		1					1		1		1
Group 3	1		1	2	1		2			2	1	
Group 4					1	1		2				
Total	4		3	2	2	1	2	3		3	1	1

known, two received less than 500 r, both of these patients and one who received less than 1,000 r had incompletely operable tumors. Two patients received from 1,500 to 2,000 r and three, more than 2,500 r.

Study of these figures indicates again that the degree of operability and the degree of malignancy are the important factors in determining the response of the patient to irradiation, because, regardless of the amount of roentgen therapy given, all but one patient with Grade III malignancy are dead.

CONCLUSIONS

1 It is important in reporting the results of the treatment of cancer by any method that the histologic diagnosis, grade of malignancy, and degree of operability be recorded and that, when radiation has been employed, the physical factors of the radiation dosage be included.

2 In this series of 22 patients, 14 had papillary cystadenocarcinoma (nine serous and five pseudomucinous), four had adenocarcinoma, three had papillary adenocarcinoma, and one patient had a granulosa-cell carcinoma.

3 Of 10 patients with tumors of Grade I, or low grade, malignancy, seven are alive, two dead, and one is untraced. Of

five with Grade II, or intermediate grade, malignancy, all are dead. Of seven with Grade III, or high grade, malignancy, six are dead and one is living for more than six years.

4 The hopefulness of prognosis is proportional to the grade of malignancy.

5 The more completely operable the tumor the better the prognosis.

6 Palliation of symptoms was frequently noted in these patients, lessening of pain and recession of edema, and while the series is too small to permit of accurate evaluation of the results of irradiation it is apparent that irradiation prolonged the life of many of them.

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RADIOLOGY AND THE RADIOLOGIST¹

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WHEN this title was presented to the Program Committee in the early part of this year, there was an honest purpose of contributing to the development of public and professional opinion upon the qualification of specialists in radiology. Another idea contributed to the increasing tendency of hospital executives to absorb the functions and perquisites of the radiologist and to make technical x-ray procedures paramount. It seems that we no sooner succeeded in squelching commercial x-ray laboratories than another more highly organized group of modern business executives began placing obstacles in the pathway of radiologic progress. Surely radiology has had a stormy career but it requires far better pilots to guide ships through stormy weather than over calm seas. Evidently we have had some wise pilots in our midst and they have endowed the rest of us with some professional courage.

Certain events of prime importance to radiology occurred this spring and summer. One was an informal demand by certain leaders in oncology upon the officers of American radiologic societies for a more satisfactory qualification of radiologists. Another was the action of the House of Delegates of the American Medical Association in the resolution to the Council on Medical Education upon the qualification of specialists, not only in radiology but in those specialties which do not as yet enjoy such autonomous institutions. Ophthalmology, Oto-rhino-laryngology, and Obstetrics and Gynecology now enjoy reliable Boards that have not as yet indulged in the American trait of bigger and better elephants.

These two events have even been woven into the fabric of radiology during the

days of this Congress of Radiology. Realizing that this was about to happen, I attempted to withdraw my title but the Chairman of the Program Committee insisted that I proceed. Undoubtedly, his idea was to provide this interlude between scientific papers with Pariseau's ascent into the realms of literary heroes and my descent to practical modes and manners.

There are so many trends in radiologic practice that it is increasingly difficult to pick out particular points.

The luck and charm of early roentgen effort, the rule of thumb, and almost the art of procedures have given way to the mechanical and electrical efficiency of modern roentgen apparatus. Likewise the efficiency methods and the research proclivities of the modern medical student have been applied to radiology, especially in the post-war period, much to its advantage. The pecuniary rewards of early radiologists have been jealously regarded by many who may have other ideals than those of Osler as a basis of their medical activities.

The glory of the pioneer radiologist has been invaded by the astuteness and the chiseling of a more modern and observing medical mentality. The freedom of the pioneer is disturbed by the efficiency demanded in hospital management and the time dishonored game of fee-splitting has been glorified into division of fees by the hospital octopus.

Radiology is a service department in diagnostics and an autonomous field in therapy. Service becomes common when it becomes indispensable. The mutual benefit of that service rests upon intelligent co-operation and sympathetic understanding of the needs of the general practitioner or specialist who seeks radiologic service. The scope of radiology is

¹ Presented before the American Congress of Radiology at Chicago Sept 25-30, 1933

broadening rapidly, and it is difficult for many to keep abreast of the accessions to its special knowledge

The primary x-ray field was merely the delineation of topographical variations in tissue densities, and thus is a large field. The introduction of opaque media into the hollow viscus, the injection of contrast air, and the production of artificial densities by intravenous chemical compounds have permitted radiology to invade fields almost beyond the realm of physiologic and anatomic imagination. The radiologist seems to spread his tennacles of diagnostic and therapeutic interest into and about the most intimate problems of every specialty. It affords a refinement never conceivable by the wildest hopes of early radiologists.

The x-ray examination of to-day with its multitude of refinements provides a definite answer to many special clinical questions and affords a comfortable corroboration of most clinical observations. The x-ray examination has progressed until the radiologist is no longer satisfied to report upon suspicious shadows, it is no longer a simple photographic technic, it is not merely the taking of films, followed by the dictated report. The x-ray examination is a systematic, painstaking procedure which uses every possibility of shadow value, properly correlated with the clinical history and social career of the patient. The x-ray examination is really a clinical examination with method, mechanics, and manifest artistry.

Radiotherapy provides an entirely different but closely associated field of medical practice. The roentgen examination, while venturing deep into clinical diagnosis, does not carry the essential responsibilities that radiotherapy forces upon the radiologist. The cancer problem looms large here. While the determination of the therapeutic procedure in the given case is a matter of co-operative examination by the surgeon, radiologist, and pathologist, if the therapy is radiologic the responsibility automatically becomes radiologic also. The radiologist has absorbed this

responsibility to an extraordinary degree in the few years that have just passed and the future may secure the gradual absorption of all non-surgical cancer therapy into the field of radiology. Radiologists seem to welcome this responsibility even though the field of oncology may not seem to present such alluring possibilities. This field of radiologic therapeutics, both roentgen and radium therapy, carries a dignity and responsibility that cannot be assailed or absorbed by technician or tyro. The ultimate results of radiologic therapy depend upon the painstaking, thoughtful application of physical and optical laws of radiant energy based upon judgment, backed by experience, and warranted by co-operative authority.

The radiologist must be granted a consultant's status. His reports must be based upon the shadow values of his x-ray examinations and their integration with the clinical career of the patient. There used to be an attitude of competition between clinical diagnosis and roentgen diagnosis. Now this seems childish and foolish. Conferences with the clinician in the roentgen laboratory serve to amplify the shadow values and bring harmony and satisfaction. Without clinical conferences and without the clinical aspects available, the radiologist is inclined to be dogmatic in his reports. This leads to embarrassing misunderstandings. It is a well-known fact and frequently expressed that there may be too much dependence upon the roentgen examination. It is used by internes and even worthy practitioners as a short-cut to diagnosis. Especially is this true in fractures, gastrointestinal and pulmonary cases. It is a great compliment to radiology, but it should not be encouraged at the sacrifice of clinical acumen. It is an injustice to the patient, equally as reprehensible as any failure to demand radiologic consultation when indicated.

The demand that the radiologist be considered a consultant carries responsibilities. The consulting radiologist must have gone through a period of training, acquired

sufficient experience in interpretation, learned the technical requirements of radiologic science, and be possessed of the art of medicine. The radiologist should be a physician practicing radiology. The possession of apparatus does not confer the degree of diagnostic ability. The specialist by assertion is quite another individual from the specialist by qualification.

There has been a tendency among many strong, well-qualified clinicians to install x-ray apparatus in their own offices. This was especially noticeable during the late, but departed, prosperous years. It was encouraged by manufacturers of roentgen apparatus. There may have been some jealousy or pique at the number and amount of cases referred to radiologists. There may have been some hope of salvaging some of the profits. Patients are trusting souls, and the convenience of the examination in the clinician's office may have obscured their appreciation of the examination's completeness and values. The glamour and the magic of x-ray ex-

aminations serve to mystify the confiding patient and lull him into a false sense of diagnostic security. There is no doubt that x-ray examinations have been oversold to potential patients and consultation radiology undersold to the profession.

There is a tendency to discontinue this inadequate roentgen examination in the clinician's offices. The overhead of thorough technical x-ray procedures is now impractical under depression stress and strain. The careful clinician is finding that this method of practice is not giving him the results hoped for. Principally, the public is demanding x-ray examinations by radiologists because of their completeness and because the costs of good examinations are identical.

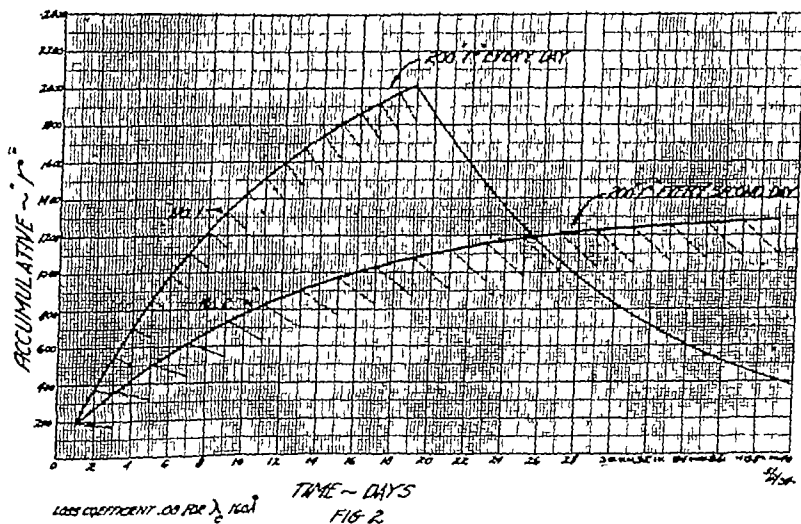
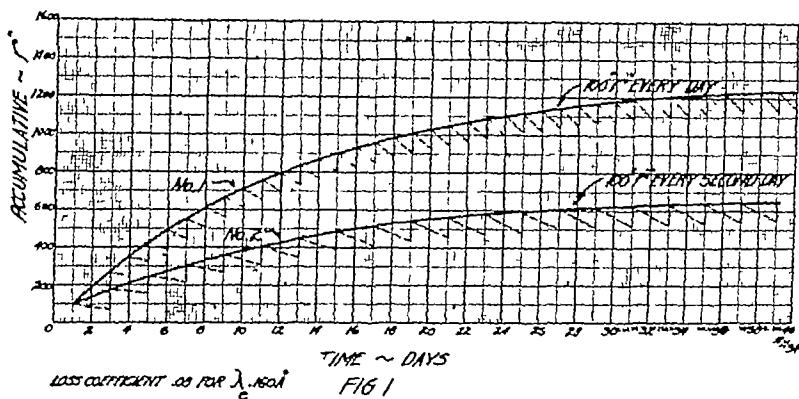
It behooves us, therefore, to subscribe to the programs which may emanate from this congress for the qualification of specialists in radiology. We must attach our influence to the general program of the American Medical Association for the qualification of specialists in all fields.

THE TOTAL DOSE VERSUS THE CUMULATIVE DOSE IN RADIATION THERAPY¹

By M C REINHARD and H L GOLTZ, Buffalo, New York

From the State Institute for the Study of Malignant Diseases, Buffalo, N Y,
Burton T Simpson, M D, Director

IN the treatment of malignancy by means of the protracted method of applying radiation with hard x-rays of λ effective 0.16 to 0.12 Å, it is possible (ing) A mere statement of the total dose in this brief manner, without the qualifying factors of time over which the treatments are extended, the increment per



to administer exceedingly large total doses. In the literature we find reports of total doses as high as 7,800 r, yet the erythema dose with one application would amount to only from 1,200 to 1,500 r (tissue scatter-

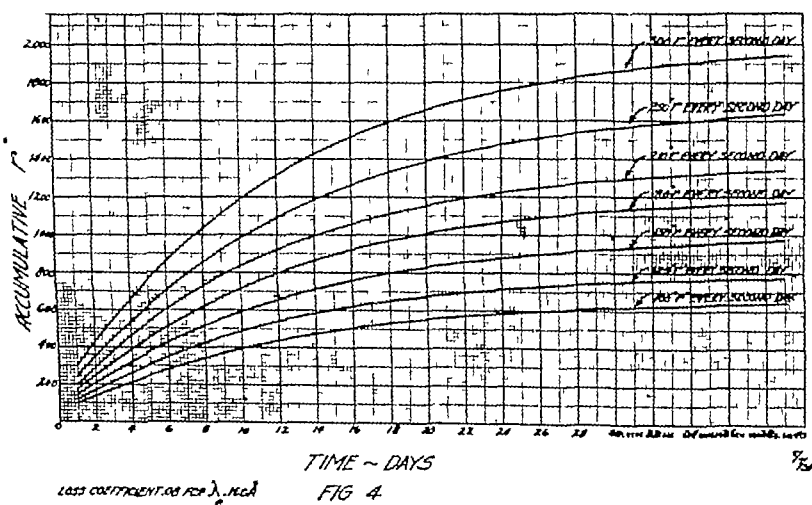
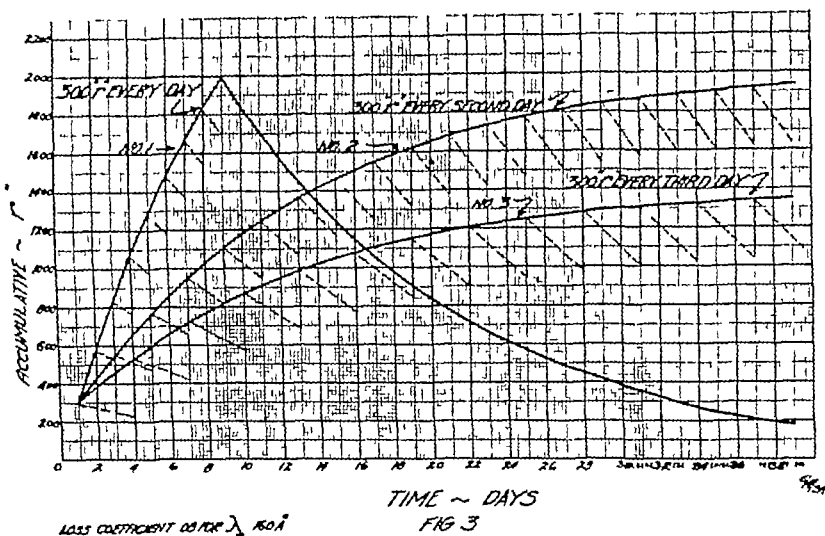
treatment, or if more than one field of radiation is used, the dose per field (in which case the total dose refers to the entire amount of radiation applied to all fields), makes the analysis of the treatment data in terms of cumulative dose (or,

¹ Received for publication May 18 1934

as it is sometimes called, the effective dose) difficult, if not impossible

In order to determine the relationship between the total and the cumulative doses, we have used increments and time

3 The cumulative doses in roentgens are plotted as the ordinates and the total time in days over which the treatments are extended are the abscissæ The day of the first treatment has arbitrarily been



intervals which might be used in actual therapeutic practice, and have calculated the residual dose by means of a coefficient representing the loss of radiation effect of 0.08 as determined by Stenstrom and Mattick (1) for an x-ray beam of effective wave length of 0.16 Å . The results of these calculations, showing the cumulative dose as it changes from day to day, are arranged graphically in Figures 1, 2, and

called the first day when plotting the data, rather than zero. The day intervals for the treatments are indicated on each figure.

In the curves the solid line indicates the values immediately following each treatment, or, in other words, it represents the residual dose plus the increment of each treatment. The broken line indicates the daily depreciation on the downward slope

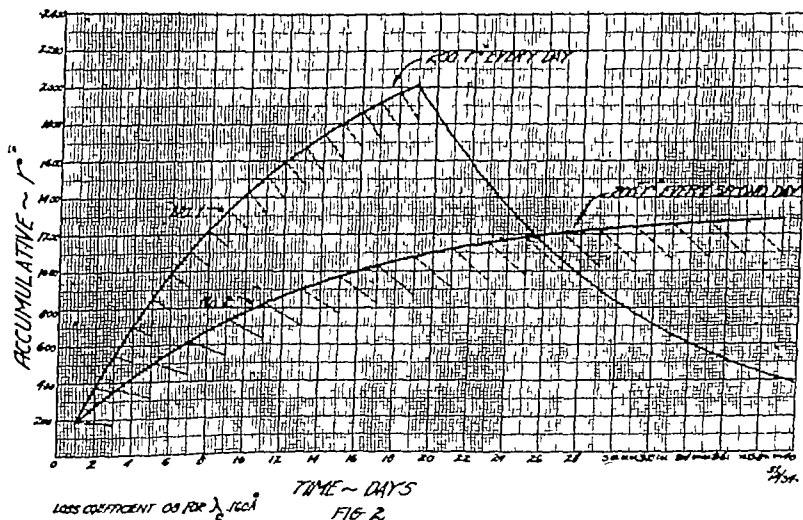
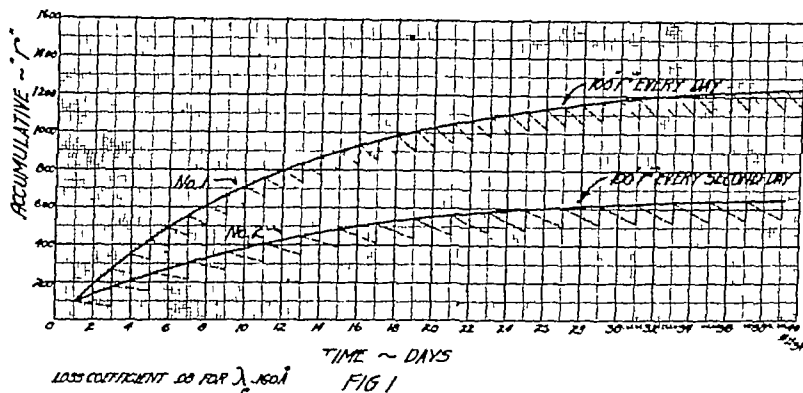
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factory clinical procedure, is beyond the scope of this paper

SUMMARY

1 The statement of total dose alone is insufficient, when protracted radiation treatments are reported. In respect to the skin effects, this report should include, in addition to the usual factors of quality of the beam and the intensity in r per minute, such information as the increment per treatment per field, and the interval for treatments of the same field.

2 Calculated on the basis that 0.08 represents a loss coefficient for hard x-rays, the information from the curves

indicates that an increment of at least 200 r daily is necessary in order to build up the cumulative dose to a peak of 200 r or more. All other combinations of increments less than 400 r and varying time intervals, except as noted in the preceding sentence, and 400 r with two-day intervals, produce a condition of equilibrium in the tissues, when the loss of radiation effect per day is equal to the increment added.

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and the daily increment added by the perpendicular line. In actual practice, treatments cannot be carried out with the regularity indicated on these curves, because of Sundays and holidays, when, as a rule, no treatments are given. When an interruption of this sort occurs, the peak or cumulative value is lowered.

The cumulative doses with increments of 100 r and intervals for treatments of one and two days are shown in Figure 1.

In Figure 2 the increment is 200 r and the intervals are the same as in Figure 1.

In Figure 3 the increment is 300 r per treatment with intervals for treatments of one, two, and three days. Although 400 r represents an increment larger than ordinarily used in protracted radiation x-ray therapy, nevertheless we have calculated the cumulative doses for this increment, assuming intervals of one, two, and three days. With one-day intervals, a peak of 2,000 r is reached following the sixth increment. With two-day intervals, a peak of 2,000 r is reached following the ninth increment on the seventeenth day. A condition of equilibrium, however, is attained with three-day intervals at a level of 1,850 r on about the fiftieth day.

An upper limit of the cumulative dose of 2,000 r has been selected for these calculations. This may represent a dose considerably in excess of that ordinarily used to produce an erythema, but, as indicated in the protracted method, more pronounced reactions are to be desired, and it has been shown by Mattick (2) that doses of this order are necessary to produce reactions bordering on epidermolysis.

It is evident from the curves that in order to build up to a peak value for the cumulative dose of 2,000 r, daily increments ranging from 200 r up are necessary. Two hundred roentgens daily build up to a peak value of 2,000 r in nineteen treatments, while 300 r daily reach the same peak in nine treatments and 400 r with six daily increments. However, with any other combination of these increments and time intervals, a peak is never obtained, as

may be seen from the curves. Instead, the cumulative value builds up to a definite level which remains unaltered with subsequent additional increments. This condition we have called equilibrium, being a level where the rate of falling off of the radiation effect is compensated for by that added each treatment. When such a condition is reached, the total dose will increase progressively with subsequent increments, whereas the cumulative dose remains constant, and as a result the relationship between cumulative and total dose cannot be expressed in simple terms. This is better expressed in tabular form (see Chart I). This state of equilibrium in the tissues with respect to radiation is comparable to a certain extent to that produced by the saturation technique. The level of the point of equilibrium, however, is dependent on both the magnitude of the increment and the time between successive treatments.

CHART I—THE CUMULATIVE DOSE IN RESPECT TO THE TOTAL DOSE WITH THE VARIOUS INCREMENTS AND INTERVALS

Dose		Increment r	Interval days	Total days	Status
Total r	Cumulative r				
7200	1850	400	3	50	Equilibrium
6000	1940	300	2	40	Equilibrium
4200	1350	300	3	40	Equilibrium
4000	1290	200	2	40	Equilibrium
4000	1240	100	1	40	Equilibrium
3800	2000	200	1	19	Peak
3600	2000	400	2	17	Peak
2700	2000	300	1	9	Peak
2400	2000	400	1	6	Peak
2000	650	100	2	40	Equilibrium

In Figure 4 there is assembled a series of curves, showing conditions of equilibrium at various levels of from 640 r up to 1,950 r, and the combinations necessary to produce these conditions.

Whether the combinations of increment and interval resulting in the formation of a peak value or those resulting in a condition of equilibrium, represent the more satis-

quantities for long periods of time is based on the theory of increased sensitivity of the cancer cell during mitosis. We believe, however, that the application of small quantities of radium for long periods of

several successive days—We believe this procedure adds tremendously to the dangers of infection and metastasis. If the uterine canal has been invaded once, we believe further intra-uterine treatment

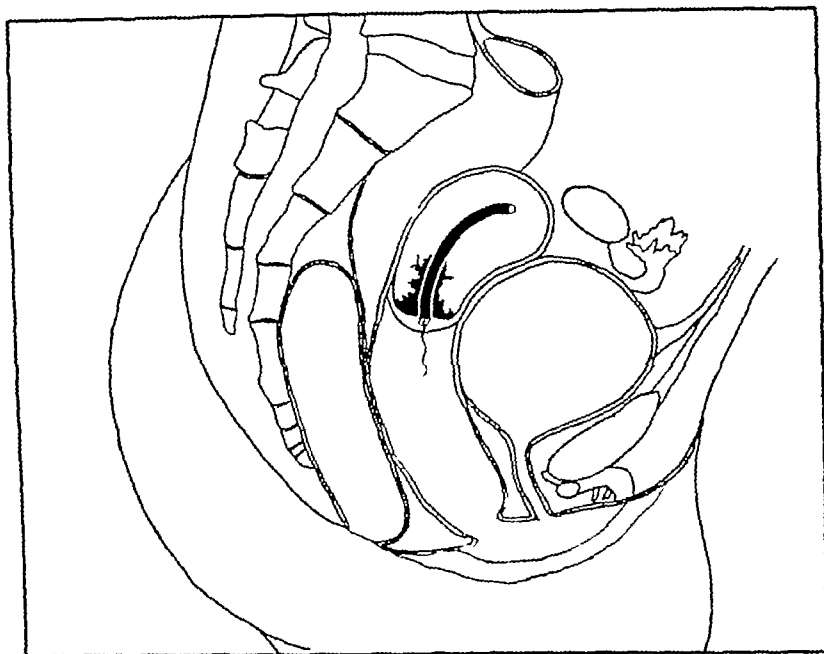


Fig 2 Six hundred mc in slender flexible lead tube in uterine canal. Introduced without dilatation after cervix becomes patent (diagrammatic)

time to metastasizing cancer of mucous membranes is a mistake, because of the traumatism and increased danger of metastasis. We have gradually adopted, therefore, the practice of using large quantities of radon, such as 1,000 mc, for short periods of time.

3 *Dilatation of the cervix*—If the cervical canal is obscured or obstructed by the cancer, as frequently happens it is impossible to introduce a tube into the uterine canal without a good deal of traumatism. Attempts to dilate the canal cannot but add to the danger of metastasis by opening up lymph and blood channels. We believe, therefore, intra-uterine treatment should be delayed until treatment against or outside of the cervix has rendered it patent.

4 *Some operators have advocated the daily insertion, withdrawal, and replacement of the intra-uterine applicator on*

should be delayed for a period of at least six weeks.

5 *Implantation of radium needles in the cervix or parametrium*—We believe the implantation method of treating cancer should be limited to small, well circumscribed lesions which experience has shown do not yield well to surface irradiation. In the presence of a markedly infected field such as is common in cervical cancer, the implantation method may cause death from infection. The dangers of inducing metastasis are also very obvious. We advise strongly, therefore, against the current practice of implanting the cervix.

6 *Dosage*—Unfortunately dosage cannot be standardized because no definite dosage is applicable to all cases. In planning dosage one must consider the location, size, and contour of the lesion.

We think the present tendency is toward too much irradiation. Some recommend

TECHNIC OF TREATMENT OF CANCER OF CERVIX WITH RADON¹

By FRANK EDWARD SIMPSON, M D , Chicago

THE character and extent of the tumor and the technic of treatment are the two most important factors in the prognosis of cervical cancer under radium. If the cancer is confined to the cervix

than the healing of cervical carcinoma when the local conditions are not too unfavorable. As much depends on the technic, we wish to discuss briefly some of the various ways of using radium

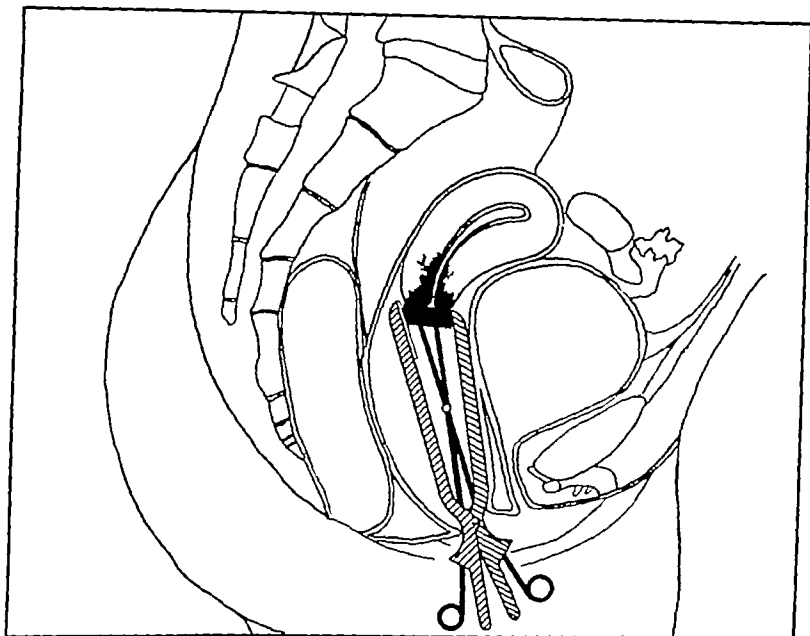


Fig 1 One thousand mc against cervix. A gold plate protects rectum. Speculum and forceps holding radon left in place during treatment (diagrammatic)

and is not made to metastasize by injudicious handling or treatment, the ultimate results are good in a considerable percentage of cases. If the cancer has spread slightly to the parametria or adjacent vaginal wall, the ultimate results may still be good provided the extensions of the growth are within the effective field of local irradiation.

If the growth has extended to the lymph nodes beyond the effective field of local irradiation, the ultimate results are poor.

Nothing in medicine is more striking

¹ Read before the American Congress of Radiology at Chicago Sept 25-30 1933

1 *Shall radium or radon be used?*—In giving intra-uterine treatment for cervical cancer radon has the advantage of being much less bulky than radium. We believe the cervix should never be dilated as long as active carcinoma is present. Radon can be introduced in a tube so small that cervical dilatation is unnecessary. The possession of sufficient quantities of radon makes the aramentarium much more flexible, but the effects of radium and radon are, of course, the same.

2 *Some recommend the use of small quantities of radium, such as 25 or 50 milligrams*—The application of small

A ROENTGEN EXAMINATION OF THE CHEST OF 500 NEWBORN INFANTS FOR PATHOLOGY OTHER THAN ENLARGED THYMUS¹

By LEON SOLIS-COHEN, M D , and SAMUEL BRUCK, M D , *Philadelphia*

THE authors, believing that the study of pulmonary roentgen pathology must begin with the newborn infant and continue throughout life, have undertaken to study the various shadows depicted upon roentgen films in the newborn infant, and present their findings (1) of existing conditions within the thoracic cage other than enlarged thymus, (2) a complete thymus study, (3) the determination of any conditions that would give rise clinically to symptoms that would be confused with the so-called dyspnea of thymic origin. The following report deals with the first phase of this study.

For the past four or five years, with the co-operation of the obstetrical department, a roentgen examination of the chest of every child born at the Jewish Hospital has been made within the first few days of its life, to determine the presence or absence of an enlarged thymus.

Within the last two years, the method adopted for this examination has been modeled after the one used by Pancoast and his confrères at the University of Pennsylvania Hospital. Each infant is examined in inspiration and in expiration and in the lateral as well as the antero-posterior position, but in the recumbent and not in the erect posture. This change was made because we felt that the newborn infant is always recumbent, and of its own volition and accord cannot assume any other position. Therefore, the effects of an enlarged thymus on the tracheal lumen must be determined in the recumbent position to judge whether or not this produces compression or displacement of the trachea in the posture natural to the patient.

The results of this thymus study are in the process of investigation and will be reported at some future time.

During the last winter [1932-33], one of our Philadelphia roentgenologists, E J Bertiu, presented before the Philadelphia Roentgen Ray Society, films of about ten newborn children which he thought showed a possible pneumothorax. This stimulated us to review our vast material of chests of newborn infants, to see whether we could find similar evidence of pneumothorax, and incidentally any other abnormalities in the chests aside from enlarged thymus.

Five hundred cases were taken, within the first week of life, without any special selection. They were listed for the following abnormalities in both the inspiratory and expiratory phases, namely pneumothorax, atelectasis, and the amount of air in the esophagus. Incidentally, we thought that we would investigate the cardio-thoracic ratio, the shape of the heart, and any abnormalities that might be encountered. These films were made at a distance of three feet and therefore the estimation of the cardio-thoracic ratio was not as accurate as if these patients had been examined in the erect posture at a distance of six feet.

Shadows of Extrinsic Origin—At the out-set, certain shadows were encountered which could not be explained satisfactorily. There were sharply defined lines noted on some of the films, which when seen on the chest only, could readily be mistaken for the outline of a non-expanded lung or compressed lung, which could conceivably be produced by air in the pleural cavity. Inasmuch as we sometimes found similar lines continuing into the abdomen or confined entirely to the abdomen, we took successive radiograms of a number of patients, and found that these lines were definitely due to skin folds, or to folds in the material used between the patient and the x-ray cassette. (See Fig 1)

¹ Presented before the American Congress of Radiology at Chicago Sept 25-30 1933

5,000 or more mc-hrs to the interior of the cervix, a dose which we regard as very excessive

Using four portals of entry (two lateral fornices, inferior aspect of cervix, interior of uterus), we believe a total dosage of 6,000 mc-hrs should seldom be exceeded

TECHNIC

We think it is futile and unnecessary to give preliminary douches or other treatment under a mistaken notion that one can "clean up" the field. The patient is in danger if we grasp the cervix with the tenaculum forceps or curette or cauterize the growth. Dilatation of the cancerous cervix should never be practised. We are opposed to making a trough for the insertion of radium tubes or to any sort of partial operation on the cervix when there is a certainty—a suspicion, even—of cancer.

Our method of attack is by surface irradiations against the cervix and lateral fornices and within the uterine canal with a large quantity of radon for a minimum of time. We believe the best results are obtained by using, as far as possible, the "selective" rather than a too "caustic" method. "Burns" should be sedulously avoided.

The cervix is exposed very carefully with a long bivalve speculum. A gold plate, 4 mm thick, is then applied to the inside of the posterior blade of the speculum relatively to protect the rectum. An applicator containing approximately 1,000 mc of radon is grasped with an 8-inch rat-toothed forceps and placed carefully against the cervix or in one lateral fornix. The radon applicator should be large enough to cover the entire growth.

We fill the speculum with gauze packing and leave the speculum and forceps carrying the radon in the vagina during the

entire irradiation, which may last only fifteen or twenty minutes. One strip of a T-binder dependent from the patient's shoulders holds the speculum and a second strip holds the forceps carrying the radon firmly but gently in position. The technique must, of course, be modified to suit individual cases.

In a few days a second irradiation is given against the cervix or in the other lateral fornix. These irradiations are continued until the estimated dose has been given.

When the cervix becomes patulous (which may occur in a few days or weeks), we introduce a flexible lead tube containing the radon into the entire uterine canal, without anesthesia and without pulling down or dilating the cervix. Being readily bent and only 4 mm in diameter, the lead tube containing the radon can be introduced as easily as a sound. A tube 7 cm long and containing 600 mc of radon may be left in the uterus four hours, but we regard this as a maximum dose. The total dosage against the cervix and in the lateral fornices should not ordinarily exceed 3,000 millicurie-hours.

The entire local irradiation may be carried out in about three weeks. The pelvic girdle may be irradiated in the usual way with the radium bomb and x-rays, but it is difficult to determine how much this type of treatment influences the final result. If cancer cells have migrated to the deeper parts of the pelvis beyond the effective field of local irradiation, all types of so-called "deep radiation therapy" are, as a rule, palliative only.

Most patients remain ambulatory during the entire treatment. Patients too far advanced for strong "curative" measures should receive only palliative irradiation, as nothing is gained and much harm may be done by severely injuring normal tissues.

it was above 50 per cent, 7 per cent have no measurements. The probabilities are that the cardio-thoracic ratio in these practically normal infants did not vary materially from the normal adult's. Farrell makes a similar statement. Whether or not the relative size of the thymus affects the cardio-thoracic ratio will be investigated in our thymus study.

Air in the Esophagus—An interesting finding was the rather frequent occurrence of cases in which the esophagus was distended with air. As a general rule, where air was present in the esophagus, it was noted both in the inspiratory and expiratory phases, sometimes being more marked in one than in the other. The presence of air in the esophagus did not depend upon the fact that the infants were examined immediately after feeding. Practically all of them, those showing air in the esophagus and those free from air in the esophagus, were examined at the same time of day, and the same period after feeding. These examinations were made in the majority of cases at least one and one-half hours after meals. The presence of air in the esophagus in itself should not be surprising inasmuch as the infants are probably constantly swallowing air, but even so it is seen much more frequently than in the older children or adults. Why the esophagus in newborn infants should retain air sufficiently long to be visualized on an x-ray film is not apparent, except the fact that in newborn infants the cardio-esophageal opening in the stomach is much more patulous than in the adult and would allow the regurgitation of stomach air into the esophagus. Still, amount or presence of air in the esophagus was not dependent upon the presence or amount of air in the stomach since there were many cases in which air was not present in the stomach and was noted in the esophagus. The fact that the infants are examined in a recumbent position may probably help to explain this finding, since it is well known that the esophagus will retain its contents longer in the recumbent position than in the erect position. (Figure 2 shows a large



Fig 2 Air in the esophagus

amount of gas present in the esophagus, producing esophageal distention. This is not evidence of cardiospasm, as in the infant spasm could not be of such intensity as to prevent air getting into the stomach. Babies that cry a lot or suck their fingers swallow air readily and the patulousness of the cardio-esophageal sphincter is more responsible for the air than the opposite condition, namely, spasm.)

Interlobar Pleura—The National Tuberculosis Association appointed a committee to determine what should be considered a normal appearance of a chest, as depicted on a roentgen film. This committee decided that a visible interlobar pleura on the right side, which, of course, is supposed to indicate thickening of the pleura, should be considered a normal finding. If we are to suppose that in order to become visible on an x-ray film, the interlobar pleura on the right side must be



Fig 1 Extrinsic line in right lung, due to a skin fold

Shape of Heart—We divided the shapes of the heart into three types, the globular, the pear-shaped, and the intermediate. It was found that in 402 cases, about 80 per cent, the heart was pear-shaped, much like the adult heart, in 90 cases, about 18 per cent, the heart was globular, and that the cardiac silhouette was intermediate between these two types in about 2 per cent of the cases. This classification of cardiac contour differs somewhat and is somewhat simpler than that noted by Farrell,² but in the main it corroborates his findings.

One would suppose that during the expiratory phase, when the diaphragmatic shadows are elevated, the heart shadow would also broaden out, and measure more than in the inspiratory phase. Farrell found such to be the case. It is definitely acknowledged by the cardiologists that the phases of respiration have more effect on the size of the cardiac shadow than does

systole or diastole. As a matter of fact, in the present investigation, the cardiac measurement decreased in the expiratory phase in 226 of the 472 cases measured, *i e*, in 48 per cent. It increased in 40 per cent, and remained practically the same in 7 per cent. This is somewhat at variance with the findings of Farrell, noted in the article quoted above, in which he states that in all his cases the chest narrows and the heart enlarges in expiration. The authors have endeavored to account for this and have thought that the following might be an explanation.

The size of the chest during respiration is determined by various factors, such as the movements of the diaphragms and the movements of the bony costal cage. In the inspiratory act, when the ribs are elevated, the transverse diameter of the chest would naturally be greater. If the costal cage does not participate to any great extent in the inspiratory act, and the changes in the size of the intrathoracic cavity are effected mainly by the movements of the diaphragms, then it is possible that during the inspiratory act, when the diaphragm descends, the transverse diameter of the heart would not be increased or may even be decreased. This is not at all surprising, for in the infant the heart lies transversely rather than longitudinally, as in the older child and adult. Hence, the apex, and for that matter any part of the heart, does not, as far as we know, at all come in contact with the diaphragm.

The authors believe that this would account for the fact that in some cases the transverse diameter of the chest increased, in some cases decreased, and in some cases remained constant. However, we must remember that respiration in infancy is chiefly abdominal rather than thoracic.

In reference to the cardio-thoracic ratio, this varied somewhat in the 500 cases. In inspiration, in 24 per cent it was below 50 per cent and in 68 per cent it was above 50 per cent. In expiration, in 13 per cent it was below 50 per cent and in 79 per cent

² Farrell John T. Jr. The Roentgen Appearance of the Chest of the Newborn Infant. *Am Jour Roentgenol and Rad Ther* August 1930 24

should be more marked and seen more frequently in the expiratory than in the inspiratory phase. It is conceivable that if there is only a small amount of air in the pleural cavity, expansion of the lung during inspiration would produce a closer approximation of the parietal and visceral pleura, and at times might obliterate the evidence of the pneumothorax entirely. As a matter of fact, the appearance suggestive of air in the pleural sac was seen in inspiration in nine cases, and in expiration in only three cases.

It is also rather unlikely that were definite pneumothorax present in these cases, there would be complete absence of clinical signs, such as dyspnea, cyanosis, and cough. In none of these 11 cases was clinical evidence present, and the observation was made in all only because we were searching for it.

Furthermore, one should be able to find some cause for the presence of air in the pleural cavity before definitely concluding that it is present, however suggestive may be the shadows observed. It is conceivable that artificial means of resuscitating an infant could produce a rupture of some of the air vesicles, through high intrapulmonary pressure from forcible inflation. A careful analysis of the history in these failed, however, to reveal even one in which artificial resuscitation had been employed. One might suppose that the pneumothorax had occurred spontaneously, from forced inspiratory effort on the part of the infant itself at birth, but in that case there should be a larger proportion of instances than we were able to find. Fortunately for these infants, none of the cases have gone to autopsy. Therefore, this method of comparison and corroboration has not been available. However, while it cannot be stated dogmatically that these shadows are demonstrative of pneumothorax, neither can pneumothorax be definitely excluded. It is logical, nevertheless, to suppose that they may represent some other condition, which we are not as yet able to recognize. Meanwhile, careful and

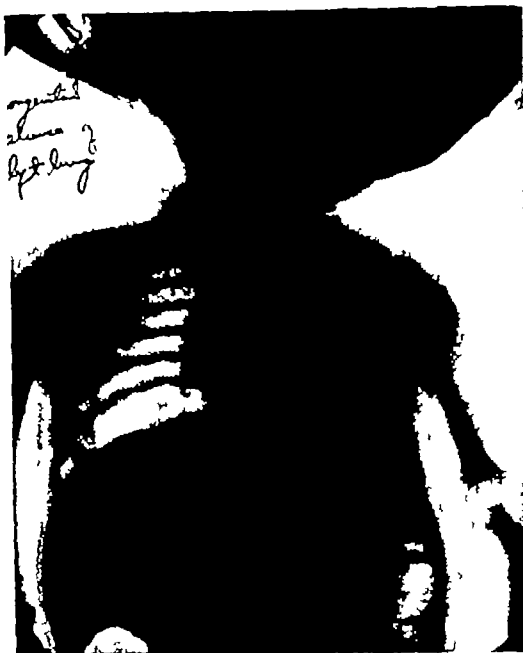


Fig 5 Congenital absence of the left lung. Note the size of the left thoracic cage.

more general studies of cases of this sort should be made. It would be well, when possible to do so safely, to re-ray such patients. Unfortunately, since this study was undertaken, no case has been encountered that showed the shadows under discussion, but opportunities for further observation will undoubtedly occur, and the results of serial studies in such instances will be reported at some future time. (See Fig 3.)

Atelectasis—In our series of 500 cases, we found 20 cases (4 per cent) that showed failure of complete expansion in both lungs. Weymuller, Bell, and Krahulik⁴ found one infant in twenty-five who showed anything suggesting atelectasis, which is in accord with our observations. The roentgen and pediatric literature recently has been paying a good deal of attention to atelectasis in the newborn infant. In order to distinguish the collapse of air vesicles consequent upon bron-

⁴Weymuller, C. A., Bell, A. L. L., and Krahulik, L., Roentgenographic Changes in the Thorax of Normal Newborn Babies, Daily Roentgenographic Study of 25 Normal Babies during First 14 Days of Life. *Am Jour Dis Child*, 1928, 35, 837-855.



Fig 3 Shadow simulating pneumothorax on right side present only in expiration

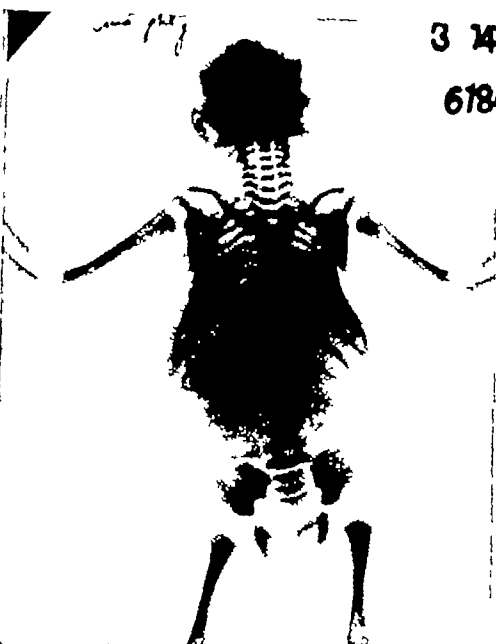


Fig 4 Anencephaly, still birth. Note that the thoracic cage is identical in size with the unexpanded lungs

thickened, it follows that this shadow should never be visible on the film of a normal newborn infant, since the possibility of a thickened pleura arising in intra-uterine life is very remote. Yet in 37 cases of the 500 (that is, 7 per cent), the interlobar pleura is distinctly visible. Our observation in respect to the shadow of the thickened pleura, confirms the finding of Charles A. Weymuller, A. L. L. Bell, and A. A. Trivilino,³ who reported the fact that in full-term infants, the line of interlobar pleura was found quite regularly, however, we did not find it quite as regularly as we were led to infer from the report of these writers.

Pneumothorax—In 11 cases of the 500, approximately 2 per cent, a distinct line could be seen on the right side in four cases and on the left in seven cases, which had the appearance of the external boundary of a compressed lung, as is so frequently

seen in artificial pneumothorax as applied in the treatment of tuberculosis. The lung-field internal to this line showed definite markings indicative of lung structure, whereas in the lung-field external to this line there was practically a complete absence of lung markings. It presented, indeed, the exact appearance of air in the pleural cavity. We are not prepared to say whether or not this is a correct interpretation. It would seem reasonable to suppose that if there actually is a pneumothorax, certain criteria should be present. Whatever the condition be, it was undoubtedly present at birth. Since some of these cases were examined three to five days after birth, at least one or two by the law of averages should have presented concomitant fluid in the pleural cavity, due to pleural irritation, as so often happens in pneumothorax, particularly of the spontaneous type. No appearance or symptoms suggesting fluid were present in any of these cases. Again, the evidence of pneumothorax should be present in both expiration and inspiration. The signs

³ Weymuller, Charles A., Bell, A. L. L., and Trivilino, A. A., Roentgenographic Changes in the Thorax of Normal Premature Babies. *Am Jour Dis Child*, March 1930, 43, 585-593.

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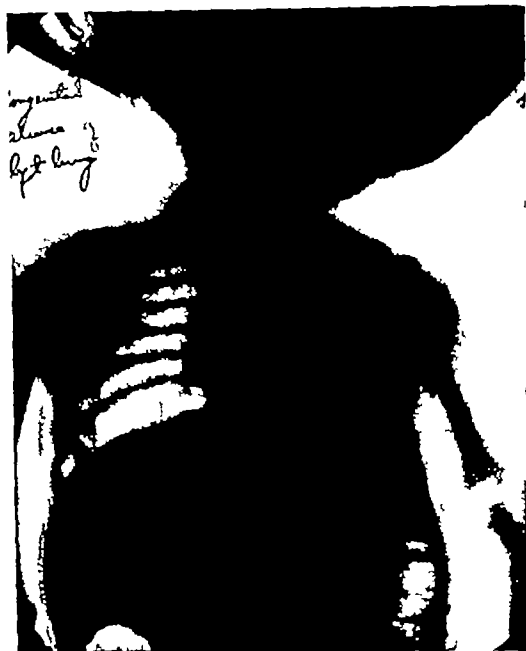


Fig 5 Congenital absence of the left lung. Note the size of the left thoracic cage.

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Fig 6 Anectasia, 24 hours after birth. Note the lobular areas of non-expansion on the right side.

Fig 7 Anectasia 48 hours after Figure 6. Note expansion of right lung.

chial obstruction from the lack of aeration due to a failure of expansion, we are inclined to use the term "non-expansion of the lung" for this latter condition, or the Greek term, *aneclasia*, restricting atelectasis to the obstructive condition (Figs 6 and 7). There is no doubt that failure to expand the lung completely occurs much more frequently than we formerly believed, and doubtless many of the cases of cyanosis that were assumed to result from thymic enlargement, were instances of such failure.

Should one expect to find the same roentgen signs of non-expansion of the lung in the newborn infant as are found in the atelectasis resulting from bronchial obstruction? The writers believe not. In the still-born infant, the pulmonary fields present a uniform density that fills up the entire thoracic cage (Fig 4). The size of the cage is identical with the size of the unexpanded lungs. When the lungs are expanded by the intake of air after birth, the thoracic cavity expands commensurately to accommodate the increased pulmonary volume. Hereafter, the thoracic cage grows with the size of the intra-pulmonary contents, but can no

longer diminish its size to conform to a decrease in pulmonary structure from obstructive atelectasis. This is well shown in Figure 5. It is the roentgenogram of a newborn infant with congenital absence of the left lung. On the right side where normal pulmonary structure is seen, the chest cavity has enlarged and expanded to accommodate the increased pulmonary volume. On the left side where no lung is present, the thoracic cavity remains flattened, unexpanded, and just the same size as it was in intra-uterine life. If then, in adult life, an atelectasis occurs in one lung or a portion of the lung, diminishing its volume, the space in the thoracic cage must be filled up by an ascent of the diaphragm and moving over of the heart and mediastinal structure to the side of the lesion, and increased aeration of the opposite lung-field with increased size of the air vesicles. In the newborn infant, however, before complete expansion, the thoracic cage is as large as the volume of the chest organs. Hence, if there be failure of complete expansion of a lung or a portion of a lung, additional or displaced structures are not necessarily pushed

tra space The pronounced cardiac and mediastinal displacements that are seen in the atelectasis of bronchial obstruction do not then occur Further non-expansion of a whole lung in the newborn is rare The form of non-expansion which usually occurs, involves either a lobe or small lobular areas throughout one or both lung-fields The authors have traced some of these cases by daily examinations or examinations every 48 hours and have demonstrated very clearly the gradual expansions of these non-expanded portions of the lungs They can, therefore, definitely state that while cases do occur in which there is partial non-expansion of the pulmonary fields, it is in the majority of these cases, a temporary condition only, and gradually clears up during the first week of life Of all the cases in which there was failure of expansion, not one was permanent, nor were any deleterious after-effects noted

One important observation was brought out by the method of examination in both the inspiratory and expiratory phases One might suppose that the evidence of atelectasis would be much more marked during expiration than during inspiration, because a part of the lung not fully expanded would show more evidence of aeration during the time of intake Again, small areas of non-expansion might be obscured by complete aeration of contiguous air vesicles during the inspiratory act In our group of 20 cases of non-expansion, four of them were noted only during inspiration, one of them only during expiration, and the remainder during both inspiration and expiration

It is very difficult to determine in the four cases, in which non-expansion was

detected, why this should be so One might well question whether a mottled increase in density throughout a lung-field or a more or less localized area of increased density in a lung-field could be a non-expansion of the lung, and yet disappear during the expiratory phase Because of these four cases, we are inclined to believe that a definite diagnosis of non-expansion of the lung should only be made if this evidence is present in the expiratory phase or during both expiration and inspiration Fortunately, if the infant is examined in only one phase of respiration, it is usually in expiration, because it is so much easier to catch a crying infant in that phase

SUMMARY

If this study has not revealed any very marked or very unusual pathologic or abnormal processes, it has directed attention to some rather interesting observations Certain it is that we must keep in mind the possibility of failure of expansion of the lung, or anectasia, as a source of those symptoms that heretofore have nearly always been ascribed to enlarged thymus We have also come to the conclusion that much more may be gained in examination of the chest of these newborn infants, and much more intelligent interpretations made of those films, if taken both during expiration and inspiration, even where the question of enlarged thymus does not enter The authors are very desirous to have other roentgenologists note the shadows which may be interpreted as possible pneumothorax and help to determine whether or not there actually is any air in the pleural sac in infants showing the appearance described

PELLEGRINI-STIEDA'S DISEASE CLINICAL AND ROENTGENOLOGIC CONSIDERATION¹

By DONALD W HEDRICK, M D , and HORACE C JONES, M D , *Detroit, Michigan*

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INTRODUCTION

FOLLOWING trauma, peri-articular calcification is frequently seen in the regions of the shoulder, elbow, hip, and knee. In the shoulder, this usually occurs in the subacromial bursa or in the supraspinatus tendon after a tear. Calcification and ossification are seen in the bursæ of the elbow or in the soft tissues after extravasation of blood accompanying fractures. The bursæ in the region of the greater trochanter of the femur are subject to trauma from direct blows. Calcification is occasionally found here. The bursa between the gluteus maximus muscle and the trochanter is most often the seat of inflammation in this region.

The knee is subjected to more trauma perhaps than any other joint of the body for the reason that it depends entirely on ligamentous structures for its stability. Because of its important functions of weight-bearing and walking, relatively minor affections are attended by great disability. It is probably for this reason that calcification and ossification, in the region of the medial femoral condyle, are considered to be important disease entities—first described by Pellegrini, in 1905, and now known as Pellegrini-Stieda's disease.

HISTORICAL

In 1905, Köhler and Pellegrini (8) independently reported this condition. Köhler's description was radiographic, it was published in an atlas on normal and pathologic anatomy. Pellegrini gave a more complete description of the disease including the history and morbid anatomy. Neither of these descriptions received much publicity. Köhler's because it was in an at-

las on anatomy, and Pellegrini's because it was in a not widely known journal which is no longer published and is now difficult to procure. To Stieda (11) belongs the credit for bringing this condition effectively before the medical profession. In 1907, he reported six cases of the disease before the third German Congress of Radiologists, at Berlin. He believed that fracture was the basic cause of the disease. This was produced by a portion of the internal condyle being broken off by external force, or by muscular contraction.

More recent authors have disagreed with this conception of the syndrome. The experimental work of Schüller and Weil (3) has thrown doubt upon Stieda's original idea of fracture as the underlying cause. Vogel, Preiser, and others have a different conception. Many articles dealing with this condition have appeared in the medical literatures of France, Germany, and Italy. So far as we have been able to determine, Kulowski (5) has written and published the only article in English describing this disease. (See note on page 188.)

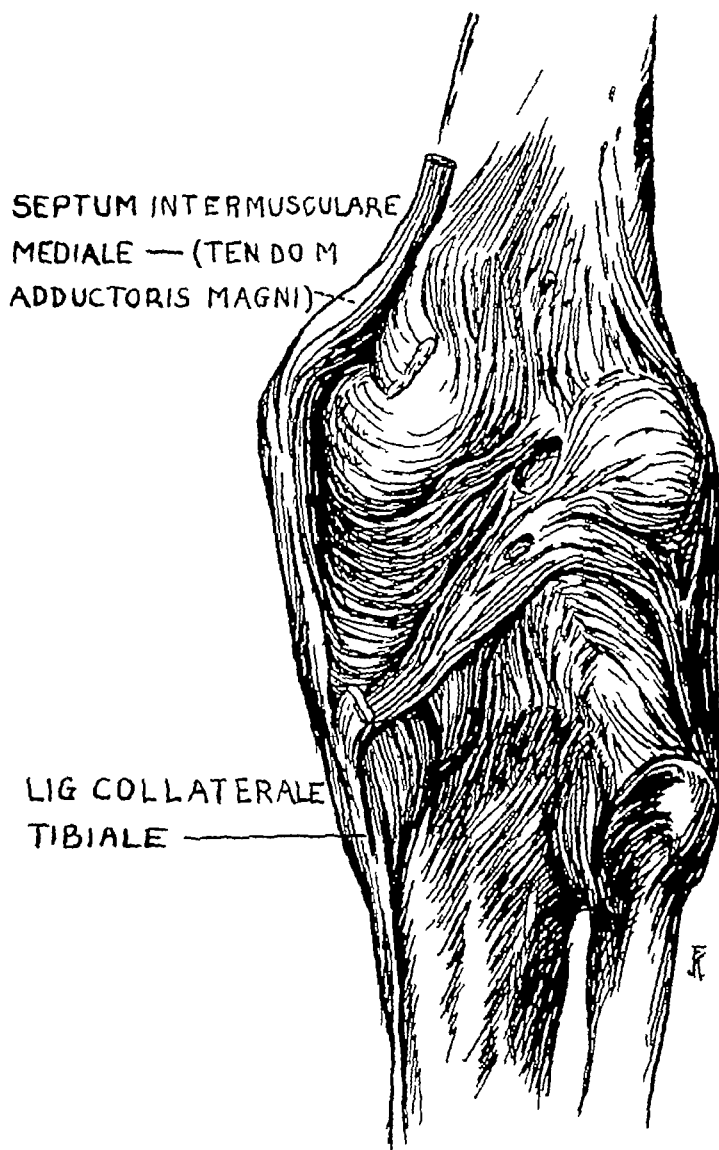
ETIOLOGY

Authors have generally agreed that the cause of this calcification is trauma. This is the result of a direct blow over the medial femoral condyle or a torsion of the knee when flexed and abducted. The medial aspect of the knee is subject to these injuries because of the following reasons. First, the distortion of the joint by forced abduction of the leg, second, the normal slight valgus position of the knee, third, the strong defensive contraction which occurs in the adductor and quadriceps muscles during stress, fourth, injury to the deep and superficial anastomotic vascular network which gives rise to the hematoma. The site of

¹ Received for publication May 8 1934

the calcification which arises from the hematoma can be seen from Figure 1. The structures involved are the internal lateral ligament or the tendons of the adductor muscles.

trauma a metaplasia from fibrous tissue to osseous tissue occurred. Stieda (11) described a fracture. He maintained that a fragment was blasted off the internal femoral condyle, and supported his conten-



RIGHT KNEE - POSTERIOR VIEW

Fig 1. Right knee from behind. Anatomic structures involved in Pellegrini-Stieda's disease: the internal lateral ligament and the adductor insertion.

PATHOLOGY

The pathogenesis from the trauma to the full-blown picture has been the subject of much discussion and numerous hypotheses. Pellegrini (8) believed that as a result of the

trauma by stating that his cases showed crepitation and increased lateral mobility. Miles (6) held that a calcification occurred in the soft tissue similar to that seen in the neighborhood of other joints. Bistolfi (1) believed that a definite periosteal

tear and displacement took place from which the new bone was formed. Ewald and others felt that the best explanation was that of a myositis ossificans. Some authors ascribe the lesion to a tear of the superior attachment of the tibial collateral ligament, others, to the adductor attachment.

Gay-Bonnet and Stefanini (4) consider it to be a local calcification. There is injury with an ossifiable medium, *i.e.*, an interstitial hematoma. Bistolfi (1) believes injury of the anastomotic vascular network in the deep and superficial structures of the knee may be a factor in producing a marked congestion in this region. In addition to the rich blood supply and the connective tissue present, the condyles furnish an ample supply of calcium for the new ossification. According to Gay-Bonnet and Stefanini (4), the following then occurs: the degenerating red blood cells are replaced by embryonal cells, congestion and edema coexist, all factors necessary for calcification are present. The calcification is thus explained by the presence, locally, of embryonal cells, congestion, edema, and the nearby storehouse of calcium.

Schuller and Weil, in 1923, injected an opaque substance into the tendon of the adductor magnus muscle in fresh cadavera. Roentgenograms of the knees were made. The films showed a semilunar shadow with its apex toward the greatest protrusion of the internal epicondyle, and with its base toward the thigh muscles. The substance was then injected in the internal lateral ligament of the knee, and the shadow in the films assumed an elongated shape in a position parallel to the epicondylar margin. The superior limit stopped suddenly just below the epicondyle. From these experiments, the authors concluded that the origin of the osseous mass was not from periosteum, but from connective tissue—a metaplasia resulting from a contusion or a tear caused by a strong contraction of the adductor magnus muscle.

The early conception of fracture of the internal condyle has been largely abandoned. The bone-like tissue which de-

velops following injury is believed by Bistolfi (1) to arise from periosteal displacement. However, he considers the surrounding connective tissue as a more important factor in producing the new-growth. According to him, the internal lateral ligament is the most frequent site of the calcification; next in frequency is the adductor insertion.

Kulowski (5) agrees with Bistolfi, Gay-Bonnet, and Stefanini that myositis ossificans is the basic pathologic process. His operative findings substantiate this.

SYMPTOMS AND COURSE

Examination soon after injury reveals local tenderness to palpation, swelling, and limitation of motion. A hematoma may be demonstrable. Hemarthrosis or hydrarthrosis are rarely found. X-ray films are negative at first, but those taken two to four weeks following injury reveal the calcifying area. Subsequent films show increasing density (this is well illustrated in Case 5). Within a few days, the pain and swelling subside but disability and limitation of motion are quite likely to persist for from one to two years. Atrophy of the adductor muscles may occur.

DIAGNOSIS

In injuries in the region of the internal femoral condyle, this disease must always be considered. The diagnosis of Pellegrini-Stieda's disease rests upon the history, physical and x-ray findings. The condition is always traumatic in origin, resulting from a direct blow over the internal femoral condyle or a violent strain of the internal lateral ligament. The disease is frequently found in industrial workers, usually men, between 25 and 40 years of age. It is rare in women and almost always unilateral.

The physical findings in a typical case are swelling, local tenderness, and limitation of motion. Hematoma may be demonstrable. Hydrarthrosis and hemarthrosis are very infrequently encountered. However, on physical examination, nothing may

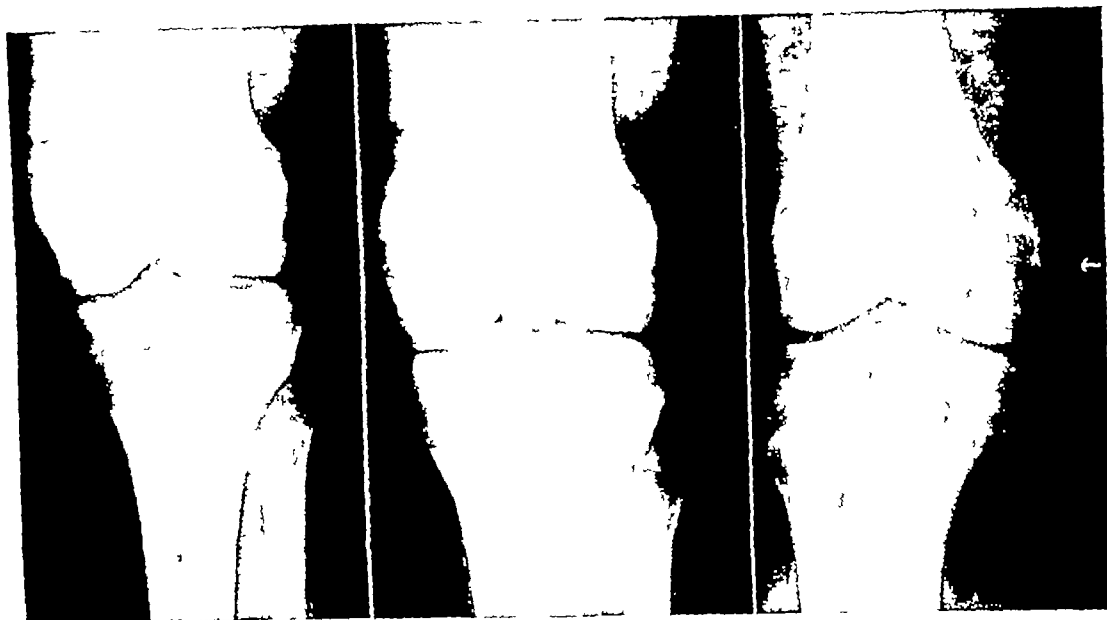


Fig 2 Case 1 Before treatment

Fig 3 Case 1 After treatment
calcification has disappeared

Fig 4 Case 2 Calcification of the internal lateral ligament

be demonstrable. This is frequently the case and the examiner is much surprised later when x-ray films are made to see a well developed calcification over the internal femoral condyle.

The x-ray findings in a typical case are as follows. There is a crescent-shaped opaque body with the concavity directed toward the condyle, but separated from the latter by a clear space. The ends are often slender. The subjacent condyle presents a normal silhouette. Nothing is seen which suggests any deformity or of depression in the internal condyle such as might occur with an osseous tearing. A patient with the above history, physical and x-ray findings presents no difficulty to the physician, as a rule, in reaching a diagnosis. In making a differential diagnosis one must exclude fracture (rare) of the internal femoral condyle, internal derangement of the knee, para-osteal arthropathies in paraplegic cases, enchondroma, and supracondylar processes.

The roentgenogram will exclude fracture by demonstration of a normal silhouette of the medial side of the femur. Internal derangements of the knee usually show no

change demonstrable on the x-ray films. Para-osteal arthropathies in paraplegic cases can be ruled out by the history. Enchondromas and supracondylar processes can be eliminated by form, continuity with the shaft of the femur, and direction of growth. The diagnosis once established, prognosis and treatment must be considered.

PROGNOSIS

A small percentage of cases may be troublesome. The ultimate picture is often not seen for from one to two years. Persistent limitation of motion, with pain, past 90 degrees of flexion, and atrophy, especially of the adductor group of muscles, are the most frequent sequelæ seen. Most cases do well under proper treatment.

TREATMENT

The treatment should include (1) aspiration of the joint, if necessary, (2) immobilization of the joint, to permit repair of the lesion. If aspiration has been necessary, a compression bandage should be applied and immobilization accomplished.

by application of a Cabot splint. If no joint effusion has taken place, a leg cast or a plaster cylinder is more comfortable. During the first week, the patient should be instructed to practise frequently active contraction of the quadriceps muscle to prevent atrophy.

Weight-bearing may be started the second week, provided the knee is supported by a compression, elastic, or felt and flannel bandage. It is not believed that this active motion will aggravate the lesion. Diathermy is by far the most valuable of the physical therapeutic adjuncts. It does no harm and often arrests the process in its development, and will sometimes promote resorption of the calcification. Massage may be permitted to the quadriceps region and the calf muscles, but is absolutely contra-indicated over or near the involved area. Many feel that massage is contra-indicated at any time, since if applied to or near the affected area it serves only to increase the congestion and edema. We feel it may be permitted to the above mentioned areas, but only after the second week. Surgery is indicated only in old cases, when the size of the mass interferes with the mechanics of the joint, but is to be thought of only after the calcification has reached completion.

CASE REPORTS

Case 1 G H, female, aged 38 years, was first seen on Feb 14, 1933. Three weeks before, she had twisted her knee while doing calisthenics. No pain or disability was noticed until one day previous to her visit. She had been ice skating and quite active in the meantime. Examination revealed tenderness to palpation over the superior attachment of the internal lateral ligament of the left knee. There was slight increase in lateral mobility and pain in the extremes of motion.

X-ray films revealed a semi-lunar shadow of increased density near the median epicondyle of the femur, typical of the calcification in Pellegrini-Stieda's disease (Fig 2). There was also some degenerative arthritis in the knee joint.

The patient was given diathermy locally and an elastic supportive bandage to the knee. Her activity was restricted for a short time. Symptoms entirely disappeared in ten days. She was last seen on March 10, 1934. There was no recurrence of symptoms. Progress x-ray films showed that the calcified deposit had disappeared (Fig 3).

Case 2 L H, female, aged 45 years, an arthritic (chronic proliferative) under treatment for symptoms referable to the right hip and knee. No history of trauma could be elicited. Few symptoms were associated with the knee. Marked limitation of motion was found. There was present a thickening of the soft tissues with local swelling and increased heat.

X-ray films showed calcification typical of Pellegrini-Stieda's disease. This was entirely an incidental finding (Fig 4). No treatment was directed toward the calcification.

Case 3 F S, male, aged 61 years, had been in a motor accident five years previously, in which he had sustained fractures of both legs. At the time of admission to this hospital he complained of stiffness of the left knee, which had been injured at the time of his accident. This was associated with arthritic symptoms in various other joints. Examination revealed no limitation of motion, but crepitus was elicited. Increased lateral mobility as compared with the opposite side was noted. X-ray films showed calcification near the median femoral condyle. The shadow measured 4 mm wide by 3 cm long. There was evidence of chronic hypertrophic arthritis of the knee joint present. We felt certain that this patient had sustained a tear of his internal lateral ligament at the time of his motor accident, which was overlooked because of his fractures and other major injuries (Fig 5).

Case 4 G K, male, aged 23 years, was admitted to the Orthopedic Clinic complaining of swelling and pain in the left knee joint, one week after a motor accident. He had been treated at the time of the accident for multiple lacerations, cerebral



Fig 5 Case 3 Marked calcification of the internal lateral ligament

Fig 6 Case 4 Roentgenogram taken immediately after injury No calcification is shown

Fig 7 Case 4 Roentgenogram taken two months after injury There is calcification shown

concussion, and contusions After his discharge, he complained of symptoms in the left knee when he resumed his activity

Examination disclosed effusion of the knee, pain on motion, increased lateral mobility, and pain on palpation along the medial aspect of the joint X-ray films were negative, except for soft tissue swelling Diagnosis of a torn internal lateral ligament was made The knee was aspirated and 150 c c of blood and serum were obtained A leg cast was applied for three weeks, after which time it was bivalved and motion begun (Fig 6) A progress x-ray film taken two months later showed a shadow of soft tissue calcification, medial to the internal condyle of the left femur (Fig 7)

The patient improved The case was removed after four weeks, and a supportive bandage of flannel and felt was worn for three weeks He was symptom-free and discharged as cured in three weeks

Case 5 M P, male, aged 46 years, was admitted to the hospital following a street

accident, with a head injury and a fracture of the right fibular head He complained of some pain in the medial aspect of the right knee A small amount of effusion was present in the knee joint

X-ray film of the knee on admission showed the fractured head of the fibula A leg case was applied for three weeks, after which time it was bivalved and a progress roentgen examination made This showed an increased shadow of density in the soft tissues in the region of the internal femoral condyle The effusion had disappeared, bakes were then started Motion in the knee was limited to 10 or 15 degrees but improved with active exercises and physical therapy The patient was discharged from the hospital on February 1 and followed thereafter as an out-patient, being last seen on March 5, 1934 X-ray films taken at that time showed a shadow not larger than before but of greater density (Figures 8 and 9 are reproductions of films made at the time of the injury and eight weeks later, respectively)

by application of a Cabot splint. If no joint effusion has taken place, a leg cast or a plaster cylinder is more comfortable. During the first week, the patient should be instructed to practise frequently active contraction of the quadriceps muscle to prevent atrophy.

Weight-bearing may be started the second week, provided the knee is supported by a compression, elastic, or felt and flannel bandage. It is not believed that this active motion will aggravate the lesion. Diathermy is by far the most valuable of the physical therapeutic adjuncts. It does no harm and often arrests the process in its development, and will sometimes promote resorption of the calcification. Massage may be permitted to the quadriceps region and the calf muscles, but is absolutely contra-indicated over or near the involved area. Many feel that massage is contra-indicated at any time, since if applied to or near the affected area it serves only to increase the congestion and edema. We feel it may be permitted to the above mentioned areas, but only after the second week. Surgery is indicated only in old cases, when the size of the mass interferes with the mechanics of the joint, but is to be thought of only after the calcification has reached completion.

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Case 4 G K, male, aged 23 years, was admitted to the Orthopedic Clinic complaining of swelling and pain in the left knee joint, one week after a motor accident. He had been treated at the time of the accident for multiple lacerations, cerebral

hematoma formation, chip fracture of the internal femoral condyle

Some months after Stieda's original article, Vogel (3) published a work on "Typical Fracture of the Internal Epicondyle of the Femur." Since then Draudt, in 1911, has written "Fracture by Tearing of the Internal Epicondyle of the Femur," and Ishimoto and Kaneko have written "Fracture of the Internal Epicondyle of the Femur." These last two, in order to establish more firmly their conviction, presented drawings done after radiographs. In these they had traced opposite the osseous shadows a gap in the femur from whence the osseous fragments had become detached. A complete account of the operation for excision of the fragments was given with a description of the condylar wound.

According to Fredet (3), a fracture and calcification in the soft tissues are not mutually exclusive hypotheses. He presents pertinent evidence which militates against fracture origin by setting forth the following conditions, which must be satisfied before a diagnosis of fraction can be confirmed. First, when the shadow of Stieda appears on the radiograph done immediately or shortly after injury, second, when the osseous shadow presents a fracture aspect (quite different from the crescentic shape usually seen), third, when the radiograph shows on the condyle by means of a depression the relief of the fragments opposite, fourth, when such a depression, an osseous defect, is found at operation, fifth, when the osseous fragment, extirpated, presents the structure of normal bone.

However, in the ordinary rule, the appearance of the osseous mass is not contemporary with traumatism. A radiograph made at the moment of the accident or in the early days thereafter shows nothing. The mass ordinarily does not appear until the second week, thus, it cannot then be considered a fragment detached from the condyle at the moment of injury. This shadow is at first scarcely apparent and increases progressively in size. Histologic examination of osseous masses has shown

them to have all the characteristics of an ossification. Such were those described by Pellegrini in 1905, Vogel in 1908, Schuller, Weil, and others.

The consensus of opinion at present seems to disfavor the fracture hypothesis and incline to the opposite view. A review of our cases from the history, radiographic, and clinical evidence favors the calcification or ossification theory. We feel certain that fractures did not exist in any of them.

SUMMARY AND CONCLUSIONS

I The history of the development of the syndrome is presented

II The etiology, pathology, diagnosis, treatment, and prognosis are considered

- 1 The etiology is always traumatic—a blow on the internal condyle or torsion of the knee when flexed and adducted, constituting strain of the internal lateral ligament
- 2 The pathologic process is essentially a myositis ossificans, though contrary opinions have been cited
- 3 The diagnosis rests upon the history and the physical and x-ray findings. The x-ray findings at first are negative. Later, roentgenograms show the typical crescent-shaped shadow with the concavity directed toward the internal condyle of the femur, but separated from it by a clear space
- 4 Treatment is conservative. In the early stages, diathermy and heat are valuable, but massage to the affected area itself is contra-indicated at all times. Immobilization for one or two weeks, followed by weight-bearing and active exercise, is the usual procedure. If

MEDICO-LEGAL ASPECTS

The relatively large groups of cases of Pellegrini-Stieda's disease reported by European clinics indicate that it is not an

too, that cases should be followed for years to determine the permanent degree of altered function

Maffei rates the disability resulting from this disease at from 5 to 10 per cent



Fig 8 Case 5 Roentgenogram taken three weeks after injury. There is shown a faint shadow of early calcification

Fig 9 Case 5 Roentgenogram taken eight weeks after injury. Note increase in density of calcification

uncommon complication of industrial injury. Maffei (7) believes that it is much more common than suspected, because the trauma is mild or minimal. It must be equally as common in this country, particularly in industrial clinics.

The question of disability then is of prime importance. Since the lesion tends to become arrested after progressing to a certain point, complete restitution of function in many cases is not permitted except for a certain degree of adaptation by the individual.

Muscular atrophy, due to disuse in the painful stage of the disease, is said to occur. Miles (6) thinks the estimate of the disability should be rated higher than that seen shortly after an accident because of possible subsequent atrophy. He feels,

Those cases of his which reached the supreme court were given 15 per cent disability. Others rate the disability from 5 to 50 per cent. It is generally felt, however, that the true figure lies between 5 and 20 per cent.

DISCUSSION

In this article we have endeavored to set forth the earlier and the present conceptions of Pellegrini-Stieda's disease. Not all foreign articles have been reviewed. A sufficient number have been read, however, to enable us to obtain an accurate idea of the European conception of the disease.

To explain the disease under consideration in this article, the following two hypotheses have been promulgated. A tendinous or ligamentous injury with interstitial

LOBITE TUBERCULOSIS

By E M VAN BUSKIRK, M D , Fort Wayne, Indiana

THE term "lobite tuberculosis" was first applied by Leon Bernard (2-4-A), in 1923, to designate a type of pulmonary tuberculosis clinically not distinct from other forms of tuberculosis but definitely differentiated radiologically by a semi-diffuse shadow, involving the entire right superior lobe, with a lobar limitation very sharply defined at the fissure

Sergent (12), who has also written on the subject, does not require a total lobar involvement for the diagnosis of lobitis. He considers the definite fissural demarcation as the most essential feature of the malady, and is little concerned whether the whole lobe or only a part of it is involved. Bernard is insistent on limiting the term to apply only to this condition as found in the right superior lobe. Most authors, however, believe that the same condition occurs in other lobes and employ the term lobitis for these as well, only prefixing the localizing modifiers, *e g*, right superior. We believe with the opponents of Bernard that the term is applicable as well to cases in which the lobar involvement is total. These two points will become evident upon the presentation of our cases.

Among others who have written on the subject are principally Aris (1) and Bethoux (2), both of whom in 1924 dedicated their inaugural theses to it, Dufourt (7, 8), Cassaubon (5), Mendez (9), and Poix (11). Perhaps the most complete work is Leon Bernard's "Les debuts et les arrêts de la tuberculose pulmonaire," published in 1931 (4).

There is considerable bickering among the various authors whether lobitis or lobulitis is the proper term to denote this condition (6). It is, no doubt, an extensive patchy alveolitis, or tuberculous bronchopneumonia, and might well, therefore, deserve the name lobulitis, but be-

cause the striking feature is the lobar involvement, with its definite lobar limitation, and because the term lobitis is now well entrenched in the literature, we believe the present usage should be retained.

INCIDENCE

Bernard gives no estimate of its frequency, but contents himself with stating that it is rather rare. Bethoux estimates the incidence at about 2 per cent of all pulmonary tuberculosis. Dufourt, from a study of over a thousand cases, gives the incidence as about 3.5 per cent. Malugani (cited by Mannucci, 10) contends that the frequency is 7 per cent. Mannucci (10), however, gives his figure as 4 per cent.

Age and Sex —All authors agree that the greatest incidence is in young adults. Dufourt states that it is most common between the ages of 20 and 40 years, Aris, between the ages of 30 and 40 years, and Mannucci between 29 and 35 years. Badoineix and Denazelle (cited by Bethoux, 2) found three cases between the ages of 18 months and 15 years. All but Mannucci agree that it is more common in females.

Location of the Lesion —Bernard, as previously mentioned, thinks lobitis occurs only in the right superior lobe. Most authors believe that right superior lobitis is the most frequent. Tocilescu (cited by Dufourt) thinks that it is found just as often in the left superior lobe. Of the 34 cases described by Aris, 22 were right superior, 8 were left superior, 2 were right inferior, 1 left inferior, and 1 right middle. Of Bethoux' 45 cases, 87 per cent were in the right superior lobe and 13 per cent in the left superior lobe. Dufourt found 32 cases in the right superior lobe and 3 in the left superior lobe. Malugani comes to the conclusion that 15 per cent of lobitis is in the inferior lobes.

Whether or not lobitis can be propagated

the mass interferes with motion, surgery is indicated

- 5 The course is usually uneventful and the prognosis favorable, but it is important from a medico-legal standpoint

III Five cases are reported

Since the preparation of this article numerous papers have appeared in American Medical literature

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dry, and fibrous transformation marks the last stage of clinical cure

There is a possibility of a pseudo-cavitary type, owing to the deviation of the trachea because of fibrous traction. The rest of the lung and the opposite side almost invariably present no clinical signs. However, whatever the symptoms may be at the time of the examination of the lobite, the clinical examination is incapable of establishing the diagnosis, which appertains only to radiology. For this, the fluoroscope is often preferable to films because of the facility with which the bulb may be shifted and the rays brought in alignment with the plane of the interlobar fissure and the definite lobar limitation thereby demonstrated.

RADIOLOGIC EXAMINATION

Bernard divides lobitis into three radiologic types (cited by Dufourt, 7)

Type 1, Homogeneous Type—The whole lobe is a dense, homogeneous shadow.

Type 2, "Crumbly" Type—Like the homogeneous type, but containing a series of clear spots which give it the appearance of scattered bread crumbs or of a honeycomb, corresponding to a patch of small cavities in the depths of the parenchyma.

Type 3, Cavernous Type—Like the homogeneous type, but having a large cavity, often huge, and usually situated medially and below the clavicle.

Dufourt concluded that the pure homogeneous type is rather rare. Nevertheless, an arbitrary division of these three types seems to simplify the concept somewhat. Usually the shadow is more complex, resulting from a combination of these elementary aspects. Generally there is a veil stretched over the entire lobe from the juxta-scissural region, which is denser. This more or less homogeneous shadow is here and there reinforced by opaque streaks and nodules, and it is on this background that the breadcrumb-like flecks and cavity shadows are superimposed.

Frequent observations on many of Du-

fourt's patients have enabled him to draw the following conclusions concerning the development and course of lobite tuberculosis, both with and without active treatment. If the patient is observed in the early stage of lobitis, there will be seen simply a more or less uniform lobar infiltration, or what appears to be a consolidation about the interlobar fissure. Several weeks later the lobe may appear uniformly dense, and may show cavities, the interlobar fissure remaining well demarkated. In fact, this latter is the most striking feature in all stages. It is to be noted that in most cases the infiltration progresses through the lobe from the fissure, and that in many instances of superior lobitis, for example, the extreme summit seems to remain unaffected for a long time, which mode of development is strikingly in contrast to that of ordinary tuberculosis. At this stage the progress may become arrested, to be ultimately followed by fibrosis, or cavitation may ensue, even in this latter case, fibrosis ultimately occurs, usually with complete obliteration of the cavities.

The subsequent picture is determined by the contraction of the fibrotic parenchyma and the retraction of the lobe from the chest wall, influenced by the opposing forces exerted by the pleural adhesions. Except in very early cases, these adhesions are very common and are found most often about the fissure and the apex. If the external portion of the fissure is fixed by adhesion, the retraction of the lung modifies the fissure in one of two ways, either elevating and distorting it, or rendering it arciform, with the concavity downward.

In rare cases in which external adhesions do not exist, the fissure tends to become more and more vertical, approaching a plane almost parallel with the mediastinum in which no trace of previously existing cavities can be detected. In a minority of the cases the retraction of the lobe is less complete, and in it may be seen small negative shadows, relics of previous cavities.

to or appear in a second lobe is a disputed point. To quote Casaubon, "Though delimited invariably by a fissure, lobitis does not always remain localized in one lobe, the tuberculous process may extend to the subjacent (unbounded lobitis or overpassed lobitis) or, better, to the opposite lung. In this latter case belongs our present patient."

ETIOLOGY

Concerning etiology most authors are relatively silent. Dufourt, however, from an examination of his 32 cases of right superior lobitis, found 9 cases which he thought represented recent, massive exogenous infections. Six other patients previously had symptoms leading one to suspect tuberculosis, as insidiously developing anemia, loss of weight without apparent cause, dry pleurisy, slight hemoptysis. Whether the development of lobitis in these six cases represents an endogenous super-infection or not, he leaves for the reader to determine. In three of his cases there was an indefinite history of contact with tuberculosis suspects, and in the remaining 14 no exogenous or endogenous infective factors could be discovered. Three of the nine cases, which, from the history appeared to be exogenous infections, showed calcified nodules either in the same or the opposite lung, so the possibility of a recrudescence of the original infection must be considered.

COURSE AND SYMPTOMS

The onset of lobitis is most often indistinguishable from the ordinary, insidiously developing case of pulmonary tuberculosis, *i e.*, there may be several of the following, anorexia, loss of weight, slight or moderate cough, etc., with or without expectoration, and perhaps an occasional streak of blood in the sputum. Bernard states that 75 per cent of the cases start in this manner.

Other cases are ushered in by a pseudo-influenzal or pneumonitic episode, while

still others are subacute in onset. But irrespective of the type of onset, the lesion is usually fully developed by the time x-ray examination is undertaken.

Also regardless of the beginning, there is usually little fever, and the expectoration is rarely profuse, or may even be *nil*, explaining the difficulty of bacteriological tests on the sputum. In rare cases the sputum is abundant and purulent. When ever sputum permits of examination, the tubercle bacilli are found especially numerous when cavities exist.

Signs—The physical signs, like the symptoms, are not peculiar to lobite tuberculosis. They, of course, vary in location with the lobe involved, but also vary within the lobe, *e g.*, in the right superior lobe they are sometimes at the extreme summit, sometimes about the crest of the scapula, sometimes near the vertebral column, very often just above or below the clavicle. One would imagine that precise physical examination could detect the definite lobar limitation of the process, but as a matter of fact this has never been done. The signs are arbitrarily divided into three classes according to the stage of development of the process.

Type A—A type of fibrous consolidation, exaggeration of whisper sounds, roughness of the respiratory sounds, sometimes gasping, dry and sonorous subcrepitant râles, sudden onset of coughing. This type can be observed primarily, or secondarily after a period of cracklings which are made to disappear by rest and treatment.

Type B—This type appears when the lesions have become caseated and the classic cavitory signs are present. Very often some cracklings, sometimes dry, sometimes moist, are heard. According to Dufourt, these are the most frequent cases.

Type C—The third symptomatologic type is produced by a complete lobar sclerosis. It is more or less of a cavitory type with localized and fixed sounds and the "growling noise described by Sabourin." Cavitory signs diminish, cavities become

dry, and fibrous transformation marks the last stage of clinical cure

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Fig 1 Case 1 Right superior lobe rather opaque with interlobular fissure well defined and a few aerated areas above fissure (Roentgenogram made June 13, 1933)



Fig 2 Case 1 A few irregular densities in sub-clavicular region, showing a marked improvement in past four months (Roentgenogram made Oct 18 1933)

The institution of pneumothorax therapy produces two very different radiological pictures, according to whether the process is recent or rather old. In rather recent cases the lung detaches itself from the parietal pleura completely and the apex, being free from adhesions, descends. The sound lobes, being of normal consistency, retract more thoroughly and the lung then takes on a pyriform appearance. In cases that have existed for some time, the almost constant apical adhesions oppose a complete collapse and the affected lobe is incompletely retracted against the mediastinum, the apex remaining fixed. The frequently existing adhesions at the lateral extremity of the fissure are sometimes thick, permitting only a very incomplete collapse. Usually, however, they are thin, and, in general, it may be said that adhesions offer no obstacle to successful pneumothorax. Phrenicotomy seems to be much less effective than pneumothorax in bringing about collapse. Even in the completely developed case of lobitis a superficial examination and interpretation of the film could still lead one into error, for it is in the proximity of the fissure that the lesions predominate, and one must

sometimes gaze intently in order to convince one's self that the lobe presents some lesions which involve at least its greater part, if not the entire lobe. However, as previously stated, the extreme summit seems to remain long unaffected and this fact is, therefore, insufficient reason for regarding it as something other than lobitis. At times it is also very difficult to differentiate a lobitis from what the French call "periscissuritis." The sub-clavicular infiltrations seen in ordinary tuberculosis are differentiated by their being situated above the fissure and by the absence of the sharp fissural limitation.

PATHOLOGY

Because of the infrequency of lobitis, coupled with its rather benign nature, only a few autopsied cases of definitely determined lobitis have come to our attention. One of these, autopsied by Bethoux (cited by Casaubon, 5), was a case of right superior lobitis of the cavitory type. The lobe was of woody hardness, a dense fissure binding it firmly to the underlying lobe. Histologically, there were knotty lesions, surrounded by a fibrous network, and more

recent lesions and extensive patches of tuberculous bronchopneumonia containing tubercle bacilli. There was much interstitial sclerosis, with thickening of the blood vessels and bronchi. In this fibrous network, macrophages filled with carbon gave the typical appearance of anthracosis.

REPORT OF FOUR CASES

Case 1 J. E., male, age 37, weight 170 pounds, presented himself on June 13, 1933, after having had a fracture reduced under ether anesthesia. There was noticed a gradual loss of weight, accompanied by a slight afternoon rise of temperature, and the patient felt rather weak.

History—A maternal aunt and a niece had died of tuberculosis, but the patient has never lived with a tuberculous suspect. Father living, has diabetes, age 70. There is no family history of cancer, cardiovascular or renal disease. Patient has a medical history of childhood diseases, pneumonia at the age of 15, and influenza at the age of 25. Patient complains of slight pleuritic pain at times.

Physical Examination—Medium sized, muscular chest, left side better developed than right, respiration free on both sides, dry râles in right subclavicular region, left lung clear.

Laboratory Examination—Wassermann negative, urine normal, repeated examinations of the sputum negative for the Koch bacillus, red blood count, 4,600,000, white blood count, 9,300, hemoglobin, 80 per cent.

Radiologic Examination—Right superior lobe rather opaque, with interlobar fissure well defined and quite dense, a few aerated areas above the fissure (Fig 1).

The second radiologic examination was made on Oct 18, 1933. The patient had been at rest since the first observation and had gained 14 pounds in weight. At this time there were still a few occasional râles in the right upper chest. Radiologic examination of the right superior lobe showed a marked change in the interlobar fissure, which was almost transparent. There

were a few irregular densities in the subclavicular region. This film showed a marked improvement over the previous one. This was a case of the homogeneous type of lobitis (Fig 2).

Comment—The homogeneous radiological type of lobitis is probably the first stage of all varieties of the affection. This may subsequently progress to cavitation or fibrosis, or it may resolve, similar to the non-tuberculous pneumonias, as evidently happened in this case. This latter mode of termination seems not to have been previously mentioned. It was to be noted that there was a relative freedom from involvement of the extreme summit in both of these films.

Case 2 B. M., female, unmarried, age 19, weight 120 pounds, presented herself on Aug 16, 1933. She complained of coughing for the last two months. She was hoarse and had sputum, which, however, was never blood-streaked, and she had a sore throat. She also complained of loss of weight and strength.

Family and Environmental History—Parents and other members of the family, living and well. A young woman working in the same office with the patient, who was employed as an office worker, has since died of tuberculosis.

Physical Examination—This revealed a pale, slightly undernourished young female. Nothing abnormal was found in the head or neck, inspection of the chest revealed nothing unusual. The heart was not enlarged, the sounds were good and there were no murmurs or arrhythmias. There were a few harsh râles in the right apex, the other lung-fields were negative.

Laboratory Examination—Urine negative for sugar and albumin, Wassermann negative, sputum positive for tubercle bacilli.

Radiologic Examination—Right superior lobe showed irregular opacities, with well-defined interlobar fissure (Fig 3).

The second radiologic examination was made on Nov 12, 1933, when her general condition appeared much improved, her cough had considerably subsided, and she

stated that she was feeling stronger and had made some gain in weight. The patient had been at rest since the previous

examination. No râles were noticed and the chest showed a decided improvement on the x-ray film (Fig. 4).



Fig. 3 Case 2 Right superior lobe shows irregular opacities, with well defined interlobular fissure (Roentgenogram made Aug. 16, 1933)

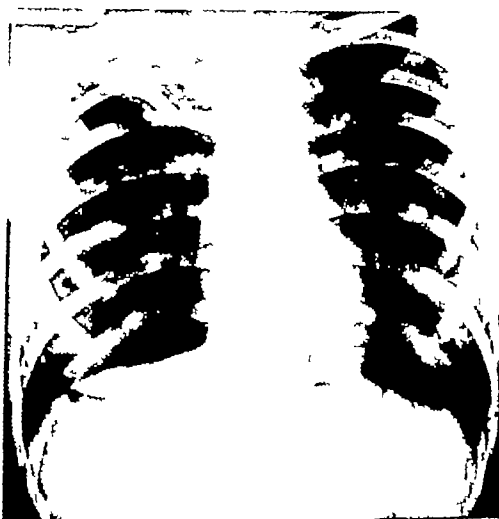


Fig. 4 Case 2 Three months later right upper lobe seems to be improved (Roentgenogram made Nov. 12, 1933)



Fig. 5 Case 3 A number of dense infiltrations in the right apex. Right inferior lobe of almost uniform density shadow stopping very abruptly at interlobular fissure (Roentgenogram made Jan. 1, 1934)

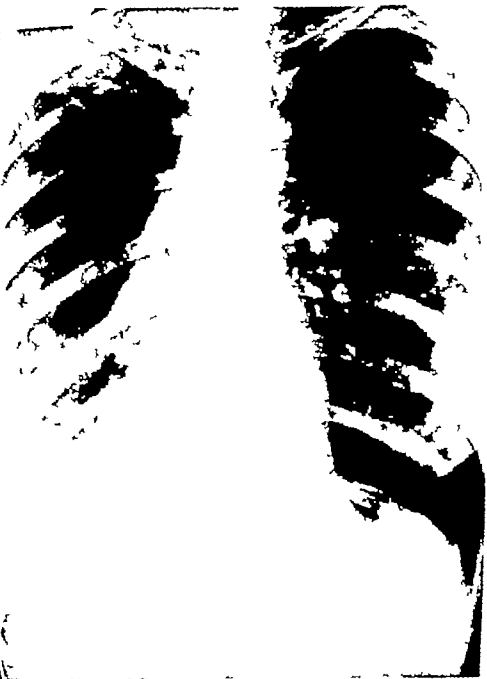


Fig. 6 Case 3 All structures of right lower half of chest retracted including pleura. Right lower lobe shrunk, causing fissure to become more vertical. Large lucid area in center of lobe (Roentgenogram made May 1, 1934)

Comment—Although the lung showed relics of childhood tuberculous infection, we are of the opinion that this was a case of exogenous infection, the source being in the tuberculous fellow office worker

Bernard (Ref 4-A) reproduces one of Tocilescu's roentgenograms which, except that it is a case of left superior lobitis, is very similar to our case, Figures 3 and 4 Bernard criticizes it on the basis of not having the fissure at the right place He agrees with Bethoux that it is a case of false lobitis due to the pleuro-pulmonary sclerosis, following pleurisy Bernard himself, however, gives a series of roentgenograms in which all but the first show the fissure at about the same position as in Tocilescu's case, except that it is on the right side He is sure that his own case is lobitis and he says that the elevation of the fissure is due to fibrotic traction He would, one might suspect, reject Tocilescu's case on the sole ground that it occurs in the left superior lobe In this as well as in the previous case, the summit remained relatively clear

Case 3 H A, female, age 30, weight 108, college instructor

Past History—The usual childhood diseases, at the age of 24 she had long-continued slight elevation of temperature At that time her doctor ordered her to bed for one month, after which he permitted her to resume her teaching, with the understanding that she rest as much as possible Since then the patient has been quite well and has passed two life insurance examinations

Family History—The father died of heart disease, the mother, a brother, and two sisters are living and well Present complaint On Dec 1, 1933, she noticed a pain in her right side which she says "felt like indigestion" She continued teaching until the Christmas recess, Dec 23, 1933

Physical Examinations—This revealed a rather slight but healthy appearing young woman, examination of the head, neck, and abdomen was negative The lower

right thorax was dull and a few constant coarse râles were present, the other lung-fields were clear



Fig 7 Case 4 Right upper lobe uniformly dense with diffuse fibrosis Many small translucent areas throughout lobe (Roentgenogram made May 4 1934)

Radiologic Examinations—The first was made Jan 1, 1934 There were a number of dense infiltrations in the right apex which were well defined The right inferior lobe was of almost uniform density, the shadow stopping very abruptly at the well-defined interlobar fissure (Fig 5) The second was made on May 1, 1934 The patient had been in bed since the previous examination The right lower lobe at that time showed considerable retraction The interlobar fissure was still well defined, but there was a large lucid area in the center of the lobe

Comment—Our second radiologic observation (Fig 4) showed a noticeable reduction in the diameter of the entire right pleural cavity The right lower lobe was considerably shrunk, and the fissure had become more vertical These alterations were all signs of an extensive fibrosis

Alterations in the right superior apex

were seen in both films, evidently due to the tuberculous infection at the age of 24. Whether or not the lobitis had its origin in the previous lesion could only be conjectured.

Case 4 Female, age 20, weight 110 pounds, student nurse

Past History—Had measles at age of 10, always healthy until about six weeks previous to examination on May 4, 1934. She had been running an irregular temperature for a short time, was hoarse, and expectorated sputum containing traces of blood. She thought she had lost about five pounds in weight.

Family History—Parents, one brother, and two sisters living and well. The patient had been in training for 17 months, and did not remember of being definitely associated with anyone having tuberculosis.

Physical Examination—Slender young female, heart of usual size, sounds normal, with no murmurs, chest negative with exception of a few very fine râles in right apex.

Laboratory Examination—Urine negative, Wassermann negative, sputum contained tubercle bacilli.

Radiologic Examination—Right upper lobe uniformly dense, with diffuse fibrosis, many small translucent areas throughout lobe.

Comment—Lungs showed some evidence of previous infection, and the writer is of the opinion this is a case of endogenous infection.

SUMMARY

The points considered are summarized in the order of their discussion.

1 Lobitis is a form of chronic pulmonary tuberculosis involving one lobe more or less completely, and having as its most prominent feature sharp, fissural limitation.

2 It can be diagnosed only radiologically.

3 The incidence is between 1 and 7 per cent of all pulmonary tuberculosis.

4 Most cases occur between the ages of 20 and 40.

5 Infants and children are rarely attacked.

6 Females are more often attacked than males.

7 The right superior lobe is most commonly involved.

8 It is questionable whether lobitis spreads to other lobes.

9 It may be a recrudescence of an earlier tuberculosis, or a new exogenous infection.

10 The symptoms are usually the same as those of the ordinary incipient tuberculosis.

11 The sputum is usually small in amount, or absent.

12 Tubercle bacilli are always found when the sputum is abundant.

13 It starts insidiously in 75 per cent of the cases.

14 The physical signs are like those of ordinary tuberculosis, and the definite fissural limitation cannot be detected.

15 There are three ill-defined clinical types and three ill-defined radiologic types, depending on the stage of development or regression (consolidation, cavitation, and fibrosis).

16 Adhesions are usually present, especially at the lateral edge of the fissure and at the apex. They alter the shape and situation of the fissure and the lobe when fibrous contraction takes place, or when pneumothorax is resorted to.

17 Four cases were presented, in three of them the lobitis was in the right superior lobe, and in one in the right inferior lobe.

I wish to thank Dr H. A. Schulz whose clinical study of these cases was of great value.

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SCATTERED RADIATION IN ROENTGENOGRAPHY OF THE CHEST¹

PRELIMINARY REPORT

By R B WILSEY, M A , Rochester, New York

SINCE the Potter-Bucky diaphragm was developed into practical form by Dr Potter in 1917, the suggestion has occasionally been made that it be adapted to roentgenography of the chest. Probably the chief reason why this has not been done is doubt as to whether the degree of roentgen-ray scattering in the chest is sufficient to justify the use of the Potter-Bucky diaphragm. An additional reason, perhaps, has been the technical difficulty of adapting the Potter-Bucky diaphragm to the special conditions of chest roentgenography, such as the short exposure times and the rapid stereoscopic shift of the cassettes. The technical difficulties can doubtless be overcome, provided it can be shown that there is any real advantage in the use of the Potter-Bucky diaphragm in roentgenography of the chest.

This question is being studied by the following methods: (1) measurement of the proportions of scattered radiation reaching the film in chest roentgenography, (2) experiments with suitable phantoms to measure the effect of the Potter-Bucky diaphragm upon roentgenographic contrast, and (3) experimental roentgenography of the human chest with the Potter-Bucky diaphragm.

With these methods, it must be remembered that contrast can be increased by lowering the roentgen tube voltage as well as by the use of the Potter-Bucky diaphragm. In either case, the exposure in terms of the load applied to the roentgen tube is increased, and the essential question is whether, with equal load on the roentgen tube, greater contrast and detail are given by the use of the Potter-Bucky diaphragm than without it.

To measure the proportion of scattered radiation reaching the film in the roent-

genography of human chests, a group of lead shot, each about 4 mm in diameter, and mounted 2.5 cm apart on a sheet of cardboard, were supported on the patient's back. The shadow of each shot on the film was thereby protected from the primary radiation of the focal spot, but recorded the scattered radiation from the patient. Density readings were made of the shot shadow on the film and of the surrounding area which was affected by both scattered and primary radiation. These density values were converted into relative roentgen-ray intensity values by means of calibration series of known exposures impressed upon the corners of the film. Both the calibration areas and the roentgenographic image received the same development. With this procedure, the resulting data on ratio of scattered to total radiation were independent of variations in either exposure or development.

Observations made on a group of normal adult chests of medium size showed that on the average, about 55 per cent of the radiation reaching the film was scattered radiation. Less than half the radiation is employed in forming the roentgenographic image, the rest merely produces a general fogging effect. The proportion of scattered radiation is not uniform in all portions of the chest roentgenogram. In the group of normal, medium sized chests scattered radiation in the shadows of the apices averaged about 50 per cent. The proportion of scattered radiation was highest in the outer borders of the lung area, where it averaged around 65 per cent. Outside the apices and the outer borders of the lungs, the proportion of scattered radiation was found to depend largely on tissue density, varying from about 40 per cent in areas where there were few lung markings to 60 per cent in areas of greater concentration of lung tissues.

¹ Presented before the American Congress of Radiology, at Chicago Sept 25-30 1933

Most pathological conditions in the lungs involve an increase of tissue density, and in observations upon patients showing lung pathology, the higher proportions of scattered radiation were observed in areas showing increased masses of diseased tissue. For instance, in a patient with a large chest (28 cm thick) suffering from anthracosis, the average proportion of scattered radiation was 66 per cent, with many areas ranging between 70 and 80 per cent. The degree of roentgen-ray scattering will doubtless be found even greater in cases of fluid or solid masses in the lungs.

The type and extent of lung pathology vary so greatly that it is impossible to formulate any general rules regarding the proportion of scattered radiation occurring in the roentgenography of pathologic areas. In any case it is apparent that the problem of scattered radiation must be seriously considered in our efforts to improve the methods of chest roentgenography.

The effectiveness of the Potter-Bucky diaphragm in chest roentgenography was investigated first by means of a phantom constructed to approximate the essential conditions of the scattering of roentgen rays in the human chest. A rectangular hollow box was made of masonite prestwood, a compressed fiber board having a specific gravity just perceptibly greater than that of water, and composed largely of the same chemical elements as comprise the soft tissues of the human body. The dimensions approximate roughly those of the human chest and the thicknesses of the walls were adjusted by trial to produce the same proportion of scattered radiation (about 55 per cent) as occurs in the normal adult chest of average size.

A test object for the measurement of contrast was prepared by drilling two holes near the middle of the central layer of the phantom, and mounting small blocks of prestwood next to each hole. Several lead shot were also mounted on the back of the phantom, toward the roentgen tube, for measurement of scattered radiation. Measurements of the contrast and propor-

tion of scattered radiation were made at various kilovoltages, both with and without the use of the Potter-Bucky diaphragm.

A special model of Potter-Bucky diaphragm was made up for these experiments by the Liebel-Flarsheim Company. The grid had a slit ratio of 1 to 8, and the lead strips were spaced $\frac{1}{32}$ inch apart. The grid itself was $\frac{1}{4}$ inch thick. The mechanism actuating the grid was constructed to permit a rapid travel of the grid for the short exposures necessary in chest roentgenography. Electric contacts on the frame of the grid were connected with the relay switch of the x-ray machine so that the movement of the grid timed the exposure. The speed of the grid could be adjusted by the turn of a knob to give exposures ranging from $\frac{1}{5}$ to $\frac{1}{20}$ second. This apparatus was especially suited for testing the value of the Potter-Bucky diaphragm under the special conditions of chest roentgenography.

Experiments were carried out with the chest phantom to determine the effect of the Potter-Bucky diaphragm upon roentgenographic contrast. The exposures were made at tube voltages ranging from 40 to 100 kilovolts on a valve rectified roentgen machine. The contrast obtained with the Potter-Bucky diaphragm was materially higher than that without the diaphragm. At 70 kilovolts, for instance, the Potter-Bucky diaphragm increased contrast by 56 per cent. Furthermore, the data show that the contrast with the Potter-Bucky diaphragm at 100 kilovolts is slightly higher than the contrast without the diaphragm at 40 kilovolts.

The Potter-Bucky diaphragm is thus more effective than a decrease in kilovoltage in improving contrast, and does so with less increase in the load on the roentgen tube. With this phantom the Potter-Bucky diaphragm increased the exposure required to about double the normal exposure without the diaphragm, whereas a reduction of tube voltage from 100 to 40 kilovolts required an increase in the energy applied to the tube to about five times the original value.

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Potter-Bucky diaphragm and the rotating target roentgen tube. These roentgenograms showed both more contrast and sharper definition than those made with a stationary target, without the Potter-Bucky diaphragm, even though the latter were made at lower kilovoltages, higher milliamperages, longer target-film distances, and shorter exposure times.

In other words, the removal of scattered radiation, and the reduction in size of focal spot were more effective in increasing contrast and sharpness in the chest roentgenogram than the use of a longer target-film distance, lower kilovoltage, and shorter exposure time.

SUMMARY

In the roentgenography of the normal adult chest of medium size, the proportion of scattered radiation reaching the film averages nearly 55 per cent. The propor-

tion varies in different areas from about 40 per cent to 60 or more per cent, the higher values occurring in areas where the lung tissues are most dense and near the periphery of the lungs. In roentgenography of such a chest, the use of the Potter-Bucky diaphragm increases contrast materially. The Potter-Bucky diaphragm may be used in chest roentgenography without loss of sharpness due to increased tube load or exposure time, provided the tube voltage is suitably increased and the tube current proportionately decreased. Under these conditions, the Potter-Bucky diaphragm produces a moderate, but definite advantage in the roentgenography of the average chest, and this advantage increases with the increase in the mass of tissue to be penetrated arising either from a larger size of patient or from pathologic conditions in the chest.

Another fact shown by these data is that with the Potter-Bucky diaphragm, a change in tube voltage affects contrast to a greater degree than is the case without the diaphragm. In passing from 100 to 40 kilovolts the increase in contrast was found to be 44 per cent greater with the Potter-Bucky than without it. Tube voltage influences contrast only in the primary image forming rays, since scattered radiation tends to mask the influence of other factors on the primary roentgen-ray image, the removal of scattered radiation should materially increase the influence of tube voltage upon image contrast.

In testing the value of the Potter-Bucky diaphragm in the roentgenography of human chests, effort should be made to avoid any increase of load on the roentgen tube, in order to avoid the necessity of increasing focal spot size or exposure time, as either of these changes has an adverse effect upon sharpness of outline.

It is possible to compensate for the increased exposure required by the Bucky diaphragm, without increase of load on the roentgen tube, by the following method. The tube voltage is increased, and the tube current proportionately decreased, until the increased roentgen-ray output is sufficient to make up for the scattered radiation removed by the Potter-Bucky diaphragm. In a typical case, it was found that a good exposure of a patient could be made without the Potter-Bucky diaphragm at 50 K V P, 500 ma, 500 foot target-film distance, in $\frac{1}{20}$ second.

With the introduction of the Potter-Bucky diaphragm, a roentgenogram of similar density could be made at 70 K V P, 350 ma, with the other conditions unchanged. By this procedure the use of the Potter-Bucky diaphragm does not involve an appreciable loss in sharpness, as neither the focal spot size nor exposure time has to be increased. When the increase of roentgen-ray exposure required by the Potter-Bucky diaphragm was compensated for in this way, the diaphragm was found to give appreciably better contrast than the technic without the diaphragm in the

case of the normal chest of average size, and the advantage of the diaphragm increased with increase in the mass of tissue to be penetrated arising either from larger size of patient or from pathologic causes.

With the chest phantom, the Potter-Bucky diaphragm was able to increase contrast by 40 per cent without necessitating any increase of load applied to the x-ray tube.

The Potter-Bucky diaphragm, therefore, offers a moderate, but definite advantage in roentgenography of the chest without requiring increased load on the x-ray tube or greater power of the roentgen machine. It produces a net gain in contrast without appreciable loss of sharpness.

In chest roentgenography with the Potter-Bucky diaphragm, tube voltages as low as 70 kilovolts give about as high contrast as is desirable in a view of the *whole chest*. However, if the principal pathology present is confined to some local area, it may be advantageous to secure higher contrast in this particular area, sacrificing detail in other portions of the chest. In such a case, the combined use of the Potter-Bucky diaphragm and low kilovoltage makes it possible to secure a degree of contrast that is not attainable by any other method.

Lowering the kilovoltage alone improves contrast *least* in those areas of the chest where the proportion of scattered radiation is highest, whereas the Potter-Bucky diaphragm has its *greatest* effect in these areas. Thus the Potter-Bucky diaphragm changes the quality of the roentgenogram, while it increases contrast in all portions of the roentgenogram, it increases contrast most in areas with the greatest proportion of scattered radiation, and thereby increases detail most in portions of the roentgenogram most difficult to improve by other methods. The Potter-Bucky diaphragm should be particularly valuable in the roentgenography of the types of chest which ordinarily give poor contrast, such as those of large and fleshy patients.

During these experiments, an opportunity was presented of making some chest roentgenograms combining the use of the

and also the changes in density with a correlation of the microscopic and roentgenographic findings

CYSTS

Cysts are associated with the state of cystiphorous desquamative epithelial hy-

perplasia were present in the right breast, with numerous small clear areas characteristic of cysts

Histology—There was diffuse polycystic mastitis

After the menopause, the roentgenogram shows varying degrees of atrophy of



Fig 1 Case 1 Numerous small clear areas characteristic of cysts Histology diffuse polycystic mastitis

perplasia The roentgen findings are characteristic, they appear as smooth, relatively clear, areas in the parenchyma of the gland If a cyst arises in a localized area of the cystiphorous state, it may present the appearance of a faint solid tumor without the dense, well-defined outline (13) A cyst containing fluid is relatively less dense than a solid tumor (18)

Case 1 Mrs W, aged 49 years, had had an intermittent bloody discharge from the right nipple for 2 years A lump was first noticed in the breast one year before examination There had been marked enlargement during the previous month, pain beginning one week later

Roentgen Examination—The signs of cystiphorous desquamative epithelial hy-


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SOLID BENIGN TUMORS

Solid benign tumors appear on the roentgenogram as circumscribed opaque areas, often multiple with a dense periphery

THE VALUE OF BREAST RADIOGRAPHY¹

By IRA H. LOCKWOOD, M.D., *Kansas City, Missouri*

 ON a properly executed roentgenogram of the breast it is important that the rays strike the breast in an exactly transverse position, otherwise there will be superimposition of the roentgenographic image. In the flaccid or pendulous breast, Seabold (17) has constructed a cradle that has proven satisfactory. In our own work we have used a rectangular compression bag capable of being filled with air after it has been placed under the patient. The technic of the examination has been described in detail in previous reports (11, 12), since then certain changes have seemed advisable. We are now using 36-inch distance, kilovoltage varying from 55 to 70, 100 ma., with an exposure of 0.3 to 1 second with the Potter-Bucky diaphragm. By using the above factors there is no distortion of the breast structure and the time is sufficiently short to eliminate movement. Several negatives using different exposures may be necessary to establish a clear concept, and the value of serial study in the diagnosis of certain conditions cannot be overestimated (7).

The roentgenogram of the normal breast shows the following four distinct anatomic zones of different densities (8): (1) The cutaneous zone, with confirmation of the nipple and skin margin in profile, (2) the adipose zone of varying degrees of thickness and showing the fibro-glandular prolongations from the mammary mass to the skin, (3) the glandular zone, with the structures appearing as a pyramid, limited at the back by the retro-glandular zone, with some irregularity of the anterior margin, especially in the region of the nipple, due to the formation of milk ducts, (4) the retro-glandular zone appearing as a smooth, narrow, clear space separating the base of the breast from the pectoral

muscles. Two distinct histologic patterns of the glandular zone have been described (4): mazoplasia and cystiphorous desquamative epithelial hyperplasia. Mazoplasia is the term given to the type of desquamation of epithelial cells in the terminal ducts and their acini, accompanied by hyperplasia of the pericanalicular and periacinous connective tissue, and often with the formation of ducts and acini. On the roentgenogram this state is characterized by a frond-like appearance of the parenchyma with the converging striations forming a fine indistinct band beneath the nipple, and a varying amount of non-opaque stroma between the mass of the gland and the derma.

Cystiphorous desquamative epithelial hyperplasia begins as a desquamative epithelial hyperplasia that ends in the formation of cysts; these breasts are often "shotty" to palpation and correspond to the state of chronic cystic mastitis. On the roentgenogram the fibro-glandular striations are marked, the parenchyma appears to fill all the available space to the derma, and there is a broad dense band beneath the nipple. It is in these breasts that both large and small cysts are found.

Between these two extremes are breasts showing characteristics of each type. Whether one accepts Cheatle's or Handley's (9) explanation of the histologic changes accompanying these different states, each presents a typical appearance on the roentgenogram.

Pathologic processes, either inflammatory or neoplastic, are shown on the roentgenogram by alterations in contour or changes in density of the anatomic zones of the breast. Through the courtesy of Dr. J. M. Wainwright, microscopic sections of the whole breast have been made showing the alterations in contour and outline of the different zones of the breast.

¹ Read before the American Congress of Radiology at Chicago, Sept. 25-30, 1933.

encountered after the age of forty (10), when the involutional changes are such that the neoplastic characteristics are easily identified. Multiple tumors are not necessarily benign, clinically, they may be

Case 2 Mrs R, aged 70 years, first noticed a lump in her left breast two years previous to examination. Shortly thereafter, it began to enlarge. She has had some pain and discomfort.



Fig 3 Case 3 Infiltration characteristic of the spread of carcinoma along the connective tissue septa. Histology mixture of scirrhous and medullary carcinoma.

appreciated by palpation as separate and distinct multiple nodules. Attention has been called to the importance of distant secondary malignancy (19) in many cases in which the disease seemed to be confined to a single nodule, microscopic sections of the whole breast revealed the frequent presence of impalpable axillary glands and involvement of the lymph structures along the pectoral muscles.

On the roentgenogram, one sees the following alterations in contour and density of one or more of the anatomic zones: the tumor appears rather dense and irregular, with interruption of the striations, the periphery may be feathery or more compact than the mass giving a false sense of encapsulation due to the compression of the surrounding tissues, extension into the lymph nodes in the axilla appears as smooth, dense, opaque areas, while the inflammatory nodes are faint and irregular in outline.

Roentgen Findings—Marked involutional changes, irregularity of the anatomic zones, thickening of the skin, an infiltrating tumor mass in the left breast characteristic of malignancy.

Histology—There was a fibrous tissue stroma with large masses of anaplastic epithelium (carcinoma).

Case 3 Mrs J, aged 44 years, noticed a lump in the left breast with a dark angry area about the nipple a month before examination.

Roentgen Findings—A marked infiltration of the entire left breast radiating from a dense mass, characteristic of a spread of carcinoma along the connective tissue septa. There was axillary involvement.

Histology—The entire glandular tissue was infiltrated, unusually shotty, and indurated. There was a mixture of scirrhous and medullary carcinoma.

Case 4 Mrs M, aged 52 years, noticed a lump in the left breast one year

but no evidence of invasion of the adjacent tissue. There may be distortion but no interruption of the striations, there is no axillary extension and no evidence of cystiphorous changes

hyperplasia, thus, with the bleeding from the nipple, warrants a presumptive diagnosis of papilloma in the absence of a mass, or a roentgenologically demonstrable tumor



Fig 2 Case 2 Infiltrating mass characteristic of malignancy. Histology large areas of anaplastic epithelium

PAPILLOMA

There are no characteristic roentgen findings to identify these microscopic lesions. The significance of a serohemorrhagic or a hemorrhagic discharge from the nipple is a moot point. Bloodgood (2) is of the opinion that it more often accompanies a benign rather than a malignant lesion. Deaver and McFarland (6) state that a bloody discharge in a majority of cases is due to papillary growths. Adair (1) says a dark bloody discharge always means a duct carcinoma. The consensus of opinion seems to be that discharge from the nipple cannot be regarded as of great significance in differential diagnoses (14). One finds on the roentgenogram evidence of cystiphorous desquamative epithelial

FIBROSIS

The roentgen appearance of fibrosis of the breast is often not as confusing as the clinical, one sees on the negatives, except in the cases of local trauma (5), many faint irregular masses of scar tissue involving both breasts, with fine striations extending into the axilla, but no abnormalities in the contour of the anatomic zones.

CARCINOMA

The roentgen identification of early carcinoma in the presence of chronic cystic mastitis before the menopause may be difficult, however, the majority of individuals who come for an examination with the history of a lump in the breast are

encountered after the age of forty (10), when the involutional changes are such that the neoplastic characteristics are easily identified. Multiple tumors are not necessarily benign, clinically, they may be

Case 2 Mrs R, aged 70 years, first noticed a lump in her left breast two years previous to examination. Shortly thereafter, it began to enlarge. She has had some pain and discomfort.



Fig 3 Case 3 Infiltration characteristic of the spread of carcinoma along the connective tissue septa. Histology mixture of scirrhous and medullary carcinoma

appreciated by palpation as separate and distinct multiple nodules. Attention has been called to the importance of distant secondary malignancy (19) in many cases in which the disease seemed to be confined to a single nodule, microscopic sections of the whole breast revealed the frequent presence of impalpable axillary glands and involvement of the lymph structures along the pectoral muscles.

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Case 4 Mrs M, aged 52 years, noticed a lump in the left breast one year

before examination Six weeks later, the skin over this area became red and infiltrated

Roentgen Findings—An irregularity in contour of the anatomic zones of the left

cystic mastitis Roentgenograms may establish the following the presence or absence of a mass, often before the disease is clinically apparent, define its mammary or axillary extensions, reveal both benign and



Fig 4 Case 4 An infiltrating mass extending from beneath the nipple back to the retro-glandular zone Histology anaplastic cells with numerous mitotic figures

breast, with an infiltrating mass extending from beneath the nipple back to the retro-glandular zone There was axillary node involvement

Histology—There was more than one tumor and, microscopically, the tissue appeared quite different There were anaplastic cells with numerous mitotic figures

The value of breast radiography is shown by the high percentage of diagnostic accuracy in the differentiation of benign from malignant lesions (20), and is exceeded only by the microscopic examination of excised tissue The limitations (14) of this method are the inability to recognize microscopic areas of cancer, early malignant degeneration in benign tumors and early carcinoma associated with chronic

neoplastic changes and the transition of a benign into a malignant lesion, depict those changes characteristic of the spread of carcinoma along the connective tissue septa—dangerous because the cells permeate along these septa—reach the more active lymph streams, and are easily carried to distant parts, offer a permanent record of the findings, be a means of serial study of the changes in the breast, offer none of the physical limitations of transillumination, and in those cases positive for carcinoma the need for biopsy can be eliminated

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FURTHER OBSERVATIONS ON THE ROENTGEN EXAMINATION OF THE AORTA¹

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Roentgen Department, Menorah Hospital

THE purpose of this presentation is mainly to revive the interest of roentgenologists in the roentgen study of the aorta. It seems that, of late, many roentgenologists have become apathetic toward this subject—a strange circumstance in view of the history of this examination.

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Levine (1), in discussing the diagnosis of aneurysm of the aorta, states "There remained a few, however, in whom the aneurysm produced no physical signs that were detectable and no particularly characteristic symptoms. Here the x-ray examination was practically the only means of detecting the underlying condition. A more liberal use of x-ray and fluoroscopy of the aorta and a more careful roentgenologic interpretation of these findings, would certainly enable us to detect some cases of aneurysm of the aorta that would otherwise be overlooked." White (3) and many other cardiologists express similar views.

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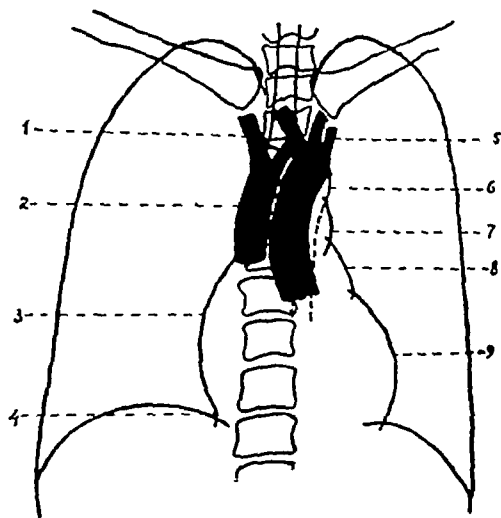


Fig 1 Model sketch showing the normal relation existing between the structures comprising the cardiac and supracardiac shadows in the normal adult sthenic type. 1 Right innominate vein. 2 Superior vena cava. 3 Right auricle. 4 Inferior vena cava. 5 Left subclavian artery. 6 Descending aorta. 7 Pulmonary artery. 8 Left auricle. 9 Left ventricle.

THE NORMAL AORTA

The normal relations of the aorta in the frontal view are illustrated in Figure 1. This was based on anatomic studies (4) with injections of barium emulsion and air into the aorta and superior vena cava. When senile changes occur, beginning about the fifth decade, the right border of the aorta tends to override the vena cava and to approach its right margin.

These relations are also influenced by the character of the aortic arch. The limbs of the arch may be closely approximated, widely separated, or rotated at various angles about the central axis of the body, depending partly on the form and course

¹ Read before the Radiological Society of North America at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

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taken during the embryologic period of development, but, to a greater extent, on the level of the diaphragm. In the hypersthenic type in which the diaphragm is high, the limbs of the arch are spread apart. In the hyposthenic type, with low diaphragm, the converse obtains. Between these two extremes, are various gradations.

In passing, I wish to call attention to the difference in distensibility of the aorta of a young adult, aged 34 years, and that of a much older individual, aged 68 years. Note the greater distention of the senile aorta with practically the same air pressure as that employed in the aorta of the young adult. The sclerotic aorta that has lost its elastic tissue is more relaxed and does not offer as much resistance as the aorta with good elastic tissue. These facts should be borne in mind when considering the changes in the aorta at different age periods and in various stages of disease involvement.

It will be recalled that the normal aortic arch does not assume a direct course from right to left in the coronal plane, but is directed anteroposteriorly in a slightly oblique plane (Fig 2). Hence, methods based on the oblique position are likely to give more accurate information concerning the aortic arch. Chaperon (5) found that the aortic arch was best observed and measured at an angle of 25° in the left anterior oblique position.

Technic—A graduated rotating platform (Figs 3-6) will be found very useful in obtaining the correct position. With this device, accurate comparative periodic observations and measurements can be made.

Direct the patient to stand erect on the platform and parallel to the plate changer. His body should be from 2 to 3 inches from the latter. Instruct the patient to make no movements whatever until he is directed. Release the lock and rotate the platform, clockwise, by hand until the indicator reads 25° . Grasp both shoulders of the patient and carefully incline him forward in a parallel direction until the left shoulder meets the plate changer. Adjust



Fig 2 Left anterior oblique position, demonstrating the entire aortic arch filled with barium emulsion

the shoulder rest seen at the upper right in Figure 5.

The exposure technic factors are 4 ft distance, 100 ma, $\frac{1}{6}$ second, kilovoltage—average size patient, 90 KV, moderately stout, from 93 to 95, and very stout, 98. All exposures are made with respiration suspended in the inspiratory phase.

The roentgenogram obtained with this technic must have sufficient density to show distinctly the ascending and descending outer borders of the arch, and the trachea with its bifurcation. Normally, the trachea is located outside of the right border of the spine and from 3 to 8 mm from it.

Description—The outer ascending and descending borders of the arch may assume a variety of forms. The ascending border may be slightly convex, straight vertical, straight oblique, or a combination of these forms. In addition to all the above forms, the descending border may be slightly concave. Moreover, the descending border, normally, before the fifth decade, does not surpass the right margin of the spine, i.e., a line joining the spinous processes

FURTHER OBSERVATIONS ON THE ROENTGEN EXAMINATION OF THE AORTA¹

By DAVID S DANN, M D,² *Kansas City, Missouri*

Roentgen Department, Menorah Hospital

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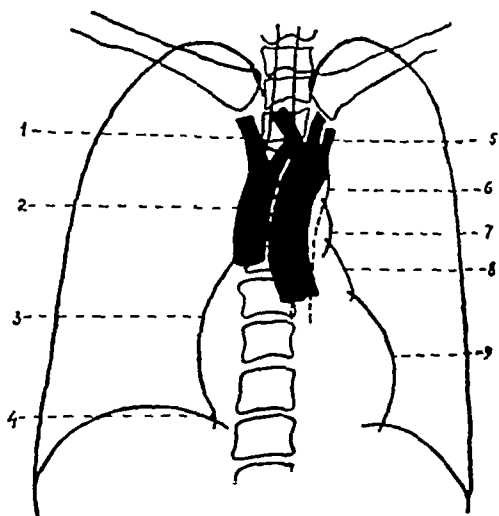


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definite aneurysm of the aorta, as distinguished from a slight dilatation of the aorta so frequent in hypertension, should widely separated limbs, exaggerated convex borders, and displacement of the descending border beyond the shadow of the



Fig 4 (left) Platform in position ready for use^{*}
 Fig 5 (center) Side view showing patient in left anterior oblique position, 25°, with adjustable rest applied to right shoulder
 Fig 6 (right) Direct view of same

be considered as positive evidence of syphilis." This view is shared by most authorities, but Kaufmann (6) investigated 24 aneurysms of the aorta and found "an equal number due to arteriosclerosis and syphilis." However, he makes the further comment that they all occurred in very elderly individuals. Aneurysm of the aorta may be associated either with an enlarged left ventricle or one of normal size, depending on the degree of involvement of the aortic valves. This will be discussed in more detail later, under the subject of dilatation and aortic regurgitation.

The detection of a dilated aorta, with its

spine, becomes an easy task after the facts concerning the normal aorta have been grasped. But the explanation of this dilatation in a particular case is a much more difficult problem.

Three conditions are in the main associated with dilatation of the aorta, namely, syphilis, hypertension, and arteriosclerosis (Fig 9). They may exist singly or in combination, *viz*, syphilis plus hypertension, syphilis plus arteriosclerosis, syphilis plus hypertension plus arteriosclerosis, and hypertension plus arteriosclerosis (Fig 10). All three conditions may be accompanied by an enlarged left ventricle.

The dilated syphilitic and hypertensive aortas, seen in the third and fourth decades, will present a smooth curve. But,

* The base of the plate changer should be elevated about 6 inches from the floor to accommodate tall individuals.

With the senile sclerotic changes occurring about the fifth decade, the aorta increases in density, and the outer borders of

at the same time, the tube is distended. The application of these facts to the study of the aorta is obvious

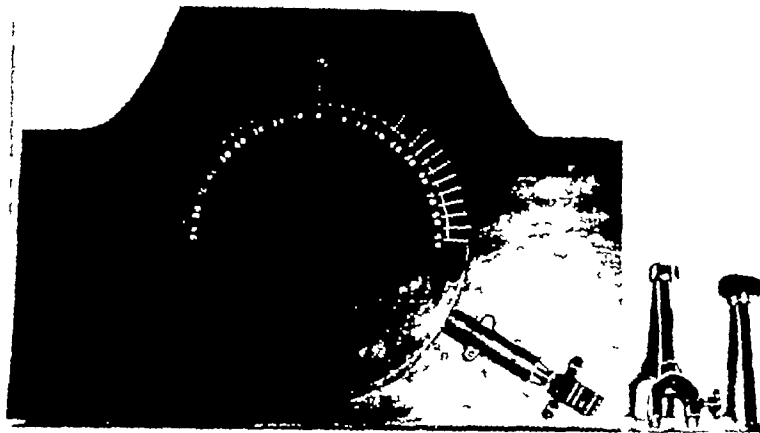


Fig 3 Platform for making oblique roentgenograms with upper surface graduated in degrees. The upper part is pivoted in the center and rotates on four ball bearings. A simple door stop brake device is located at the side.

the arch become more convex, elongated, and tortuous. This is the senile type of uncoiling.

It will be noted that all observations and measurements relate to the outer borders of the arch, which are plainly visible, while the others are not. I am unable with the present technic to visualize the latter before the period in which senile changes take place. However, until a technic is obtained which will enable us to see all borders of the arch, we must depend on indirect methods.

In this connection, it is interesting to speculate concerning the possibilities of observing the anterior and posterior borders of the individual limbs with the use of 1,000 milliamperage technic and a constantly moving Bucky diaphragm.

It is obvious from a study of simple tube mechanics that the outside measurements of a coil will indirectly indicate the caliber of the individual limbs. Figure 8 illustrates the changes that take place in an ordinary rubber tube subjected to air pressure, when both ends have been previously fixed in position. As the pressure is increased, the limbs of the coil tend to separate and the arch becomes elongated,

Roentgenographic and fluoroscopic observations of the heart and aorta should be made in all positions. Moreover, at the risk of stating a platitude, the roentgen observations should always be correlated with the history, physical findings, and the data obtained from other clinical methods of investigation.

THE PATHOLOGIC AORTA

Having established the technic for examination of the aorta, and appreciating the manifold character of its normal contours, we are in a position to study the pathologic changes to which it may be subjected. For our purposes, there are two major disturbances that may occur, namely, aneurysm and dilatation.

I shall not enter here into a discussion concerning the differential diagnosis between aneurysm and the conditions which may simulate it. A careful study of the roentgenograms in all positions, together with the roentgenoscopic observations, will, with few exceptions, readily establish the eccentric, sharply outlined, fusiform or sacculated protuberance of the aorta.

Levine (1) states, 'The discovery of a

process widens the commissures by causing adhesions of cusps to the aortic wall and, by separating the cusps, produces regurgitation. This is the reverse of the usual rheumatic effect, which tends primarily to unite the cusps at the commissures, to cause stenosis rather than regurgitation. Extension of the luetic process may further damage the valve cusps themselves and cause their retraction or adhesion to the sinuses of Valsalva. A weakening of the aortic valve ring, with stretching, often comes with aortitis. Thus aortic regurgitation, so frequently complicating luetic aortitis, may result either from this stretching alone or from damage to the valve, or from both factors. The aortic regurgitation results in dilatation of the left ventricle (Fig. 11)



Fig. 9 Dilated aorta in hypertensive heart disease. Wide arch with descending border displaced beyond interspinous line.

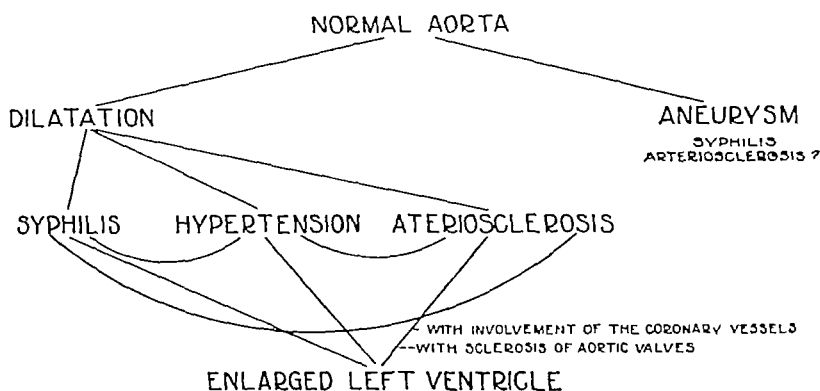


Fig. 10 Diagram illustrating the two most important pathologic changes in the aorta and the etiologic factors involved. The relation to enlargement of the left ventricle is also demonstrated.

The fact that the enlargement of the left ventricle takes place, usually secondary to the involvement of the valves, accounts for those cases in which the aorta exhibits an aneurysm and the heart shadow appears normal in size.

These facts have still further significance in that they may be utilized to differentiate between syphilitic and rheumatic, or non-specific, valvular disease. The latter type is very rarely associated with a dilated aorta. Therefore, a diagnosis of syphilitic valvular disease can usually be made with the aid of the roentgen examination

when the following conditions obtain: patient younger than 50, with an aortic diastolic murmur, dilatation of the aorta, and enlargement of the left ventricle, but no hypertension. On the other hand, if the above conditions prevail without dilatation of the aorta, then the converse is true, namely, rheumatic, or non-specific, valvular disease. These observations confirm those made by Holmes (9).

A statement concerning the roentgen changes in the early stages of syphilitic aortitis may not be amiss, although this should hardly be necessary. Occasionally,

from this period on, they will be associated with the tortuosity and density resulting from arteriosclerosis. It is in the latter

untreated patients to an average of 65 months in patients receiving one year or more of such treatment."



Fig 7 Left anterior oblique roentgenogram
Sthenic type age 27 years

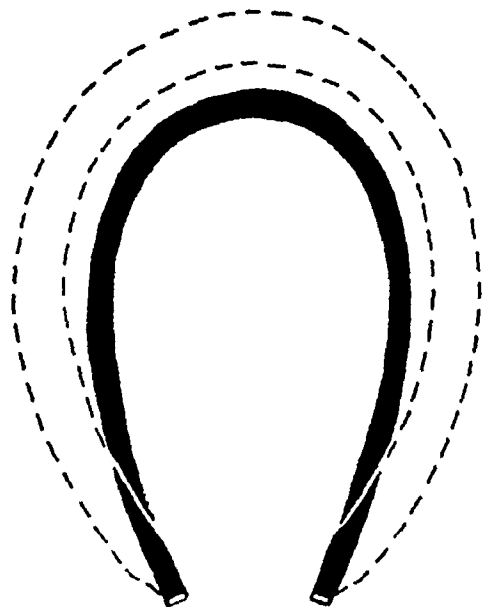


Fig 8 Illustrating the changes that take place in an ordinary rubber tube both ends of which have been previously fixed in position, when it is subjected to air pressure. The shaded portion shows the tube before distention. The broken lines indicate the shape after air pressure has been applied. Note that as the tube is distended, the limbs separate and the arch is elevated.

period that the posterior mediastinal borders of the aorta may be visualized, but not before.

Let us consider in more detail the most important of these three types, namely, the syphilitic. After all, so far as treatment is concerned, we are most interested in this type. The observations of Moore and Danglade (7) are pertinent. "A study of 43 patients with aortic aneurysm demonstrates that life may be prolonged from an average of nine months from the onset of symptoms, in untreated patients, to an average of 69 months in patients receiving one year or more of such treatment. A study of 90 patients with aortic regurgitation and eight with various other forms of syphilitic cardiovascular disease shows that life may be prolonged from an average of 32 months from the onset of symptoms in

A thorough appreciation of the pathology of the syphilitic process in the aorta is essential to an understanding of the roentgen changes. White's (8) excellent description is quoted briefly: "Three important developments of this destructive luetic aortic process may occur (A) a stretching of the aortic wall to give rise either generally to a spindle-shaped dilatation or aneurysm, or locally to a sacular aneurysm, (B) an involvement of the aortic valve to deform it and to cause aortic regurgitation, and (C) a narrowing of the mouths of important branches of the aorta by an extension of the luetic process itself. (B) Aortic valve disease is due to a downward extension of the aortitis to involve primarily the commissures of the valve. The inflammatory

of Aortic Aneurysm *RADIOLOGY*, August, 1931, 17, 304-316

(3) WHITE, PAUL D. Observations on the Clinical Value of Roentgen Ray in Diagnosis of Cardiovascular Disease *Am Jour Roentgenol and Rad Ther*, April 1930, 23, 353-357

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(5) CHAPERON, M. Contribution a l'Étude anatomoradiologique des Vaisseaux de la Base du Cœur Paris, Thèse No 583 1920-1931

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(6) KAUFMANN, EDWARD *Pathology for Students and Practitioners* P Blakiston's Son & Co, Philadelphia, 1929 Vol 1, p 136

(7) MOORE, JOSEPH EARLE, and DANGLADE, JAMES H. The Treatment of Cardiovascular Syphilis, Study of Duration of Life in 141 Treated and Untreated Patients with Aortic Regurgitation and Aortic Aneurysm *Am Heart Jour*, October 1930, 6, 148-156

(8) WHITE, PAUL DUDLEY *Heart Disease* The Macmillan Co, New York 1931, pp 360-362

(9) HOLMES, GEORGE W. X-ray Observations in Aortic Regurgitation *British Jour Radiol*, 1926, 31, 409-418

one observes patients presenting the characteristic features of syphilitic aortitis, *i e.*, precordial distress, dyspnea, and

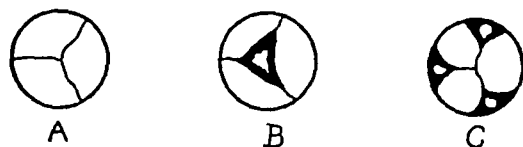


Fig 11 Diagrammatic sketch⁴ illustrating the difference between aortic regurgitation resulting from rheumatic or non-specific valvular disease (B), and syphilitic valvular disease (C). Note that in the former the free margins are affected, while in the latter the valves are separated at the commissures by the syphilitic process which has extended downward from its supra-valvular origin. A represents the normal relation of the valves.

positive Wassermann, yet in whom no dilatation or aneurysm of the aorta can be detected. It should be readily appreciated that the early involvement of the adventitia and media by syphilitic process may not cause sufficient destruction of the elastic fibers to effect a dilatation or aneurysm. This is especially true before the fourth decade, when the aorta still retains abundant elastic tissue. Mention was made in the early part of this presentation concerning the difficulty of distending, experimentally, the aorta in a young adult. In such cases, however, it is advisable to make serial observations of the aorta during the course of treatment and thereafter, to determine the progress of the disease.

SUMMARY

1 The roentgen examination will disclose syphilis of the aorta in from 10 to 30 per cent of the cases in which it is not detected by other means.

2 It is obligatory, therefore, for roentgenologists to take an active interest in this subject and to make still further contributions.

3 The diagnosis of an aneurysm of the

aorta, and particularly dilatation, depends upon a clear conception of the normal aorta.

4 The aorta is best studied in the left anterior oblique position at an angle of 25°.

5 A graduated revolving platform is described for making roentgenograms in this position. The technic for its use is given in detail.

6 Until a technic is obtained whereby the outlines of the individual limbs of the aortic arch are plainly visualized, reliance must be placed on indirect measurements.

7 An appreciation of simple tube mechanics will aid in the study of the aorta.

8 The characteristics of the normal aortic arch are described.

9 Periodic health examinations, utilizing roentgen studies, may disclose an aneurysm or dilatation of the aorta in its early stages.

10 The presence of an aneurysm of the aorta, with the questionable exception of arteriosclerosis, will establish the diagnosis of syphilis.

11 Dilatation of the aorta is commonly found in syphilis, hypertension, and arteriosclerosis. These may exist singly or in combination.

12 The characteristics of the arteriosclerotic aorta must be appreciated to understand the roentgen changes in syphilis or hypertension when it is a coexistent factor.

13 A clear conception of the pathology of syphilis is essential to an understanding of the roentgen changes in the heart and aorta.

14 A differential diagnosis can be made between syphilitic and rheumatic, or non-specific, valvular disease with the aid of the roentgen observations.

15 At the risk of stating a platitude, the roentgen examination should always be correlated with the history, physical findings, and other clinical methods of investigation.

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⁴ Personal communication from Dr. Robert Kortschoner, pathologist at Menorah Hospital.

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OPAQUE MEDIA IN UROLOGY, WITH SPECIAL REFERENCE TO A NEW COMPOUND, SODIUM ORTHO-IODOHIPPURATE¹

By LEOPOLD JACHES, M D , and MOSES SWICK, M D , *New York City*

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THE term pyelography or pyelo-ureterography is universally accepted as defining the roentgenologic demonstration of the urinary conducting system—calices, pelvis, and ureter—with the aid of substances opaque to the x-rays. This method of investigation, historically, is intimately associated with the development of various opaque media in their application in urology. The substances to be considered for this purpose may be classified as

- 1 Colloids
- 2 Crystalloids

{	inorganic halogens— iodides or bromides organic halogens
---	--
- 3 Gases—oxygen, carbon dioxide, and air

The first crude but stimulating attempts at delineating the pelvis and ureter were made by Tuffier in 1897, and Schmidt and Kolischer, Löwenhardt, and von Illyes, by means of mandarins passed through ureteral catheters, and opaque bougies. The first impetus to the delineation of the urinary tract with the aid of opaque media should rightfully be attributed to Wulff, of Hamburg. He outlined the urinary bladder by means of injection of a suspension of bismuth subnitrate. Voelker and von Lichtenberg working with collargol reported, in 1905, their experiences with the visualization of the urinary bladder. In the course of their work they were able to see the ureter and pelvis outlined in a case of unilateral vesico-ureteral reflux. In 1906, as a consequence, they published their results on retrograde pyelography with the aid of collargol injected through a ureteral catheter, and were thus the first

ones to completely and satisfactorily outline roentgenologically the pelvis and calices.

Other observers subsequently have utilized stronger solutions of collargol. Argyrol, as well as a 5 per cent emulsion of silver iodide, were the other silver compounds employed. Although in some hands these media have met with success, the use of the silver salts was finally abandoned, fatalities having been recorded, in part due to the character of the medium employed. For example, local necrosis in the kidney, silver embolism, and general poisoning, were some of the untoward reactions encountered.

A distinct improvement on the above media came with the advent of a 10 per cent solution of thorium nitrate, introduced by Burns, in 1915. This substance led to the gradual exclusion of the colloidal silver compounds. Associated irritative phenomena and fatalities were the objections raised to it. Yet, for three years until the advent of the inorganic halogens, this medium was the one of choice.

A notable advance occurred, in 1918, when Cameron suggested sodium and potassium iodide in watery solution, and Weld proposed sodium and potassium bromide. The potassium salts in both cases were quickly ruled out because of the depressant effect of the potassium-ion, particularly on the heart, as borne out by experiments on dogs with the intravenous injection of these salts. Based on these researches and clinical experiences, sodium iodide and bromide have come into almost exclusive use as pyelographic media. With regard to the comparative values of sodium iodide and sodium bromide, the former has been found to be superior for the following reasons:

¹ Presented before the American Congress of Radiology at Chicago Sept 25-30, 1933



Fig 1 Intravenous urogram, in a case of vesico-vaginal fistula of tubercular origin, incidental to renal tuberculosis of a left excluded kidney. The urine was repeatedly negative for tubercle bacilli. A biopsy of the bladder in the region of the fistula showed tuberculosis. The right urinary tract reveals dilatation of the ureter, pelvis, and calices with angulation and kinking of ureter.



Fig 2 Intravenous urogram in a case of right non-functioning calculus hydronephrosis. The left urinary tract is dilated, the result of a stone situated over the lateral aspect of the midsacral region.

1 Its greater molecular weight, giving a radiographic shadow of greater density with a solution of much lower concentration.

2 The iodide component is a member of a group of elements which show an opacity to x-rays beyond what their atomic weight would indicate.

3 The osmotic pressure of sodium iodide in the concentration used for pyelographic purposes is only slightly greater than that of concentrated urine, and, of all the various substances used, is the least hypertonic. The question of hypertonicity becomes important when it is realized from animal experimentation as well as from clinical observation that, other things being equal, the injurious ac-

tion upon living tissues varies with the degree of hypertonicity. And herein lies the rationale for the general acceptance of a 12 per cent solution of sodium iodide for retrograde pyelography.

In passing, brief mention should be made of other media and procedures advocated, and in many instances subsequently discarded.

A Media—1 The use of oxygen, air, or carbon dioxide—the objection to these media being confusion with overlying intestinal gas, the difficulty of maintaining full distention of the pelvis and ureter, and air embolism. One of the authors (Jaches) has been misquoted as having advocated the use of air or oxygen. On the contrary, in the paper which he, in collaboration with



Fig 3 Intravenous urogram, in a case of a left calculus hydronephrosis. There is non visualization of the left urinary tract incidental to the functional-anatomic derangement of the kidney parenchyma. The right urinary tract shows dilatation of the calices, pelvis, and ureter. This case illustrates the value of non visualization as a means of localization of the disease.



Fig 4 Oral urogram showing dilatation of the upper urinary tract of the remaining right kidney after nephrectomy of the left one was performed for calculus pyonephrosis.

Dr Furness, presented, in 1911, which was not published but from which this quotation seems to have been derived, he distinctly stated that air or oxygen is distinctly inferior to metallic solutions for the reasons above stated.

2 Umbrenal or lithium iodide—this solution is expensive and frequently irritating, producing spasm of the calices and pelvis.

3 Lipiodol—of an oily consistency, has a tendency to globule-formation in the presence of aqueous solutions.

4 Umbrathor—a colloidal suspension of thorium dioxide, is similarly viscid, making emptying by the renal pelvis difficult. Its use in cystography, however, has definite advantages. The question of emptying in the case of the bladder is relatively of no consequence.

5 Neosilvol—in 20 per cent concentration has objections similar to lipiodol and umbrathor.

B Procedures—1 Perirenal and pericysto-pneumoradiography, a procedure by which oxygen is injected around the kidney and bladder, respectively. It has been practically discarded because of the meager information obtained and above all the attendant danger of air embolism and infection.

2 Pneumoperitoneum is the injection of oxygen into the peritoneal cavity for the differentiation of intra- and retroperitoneal masses. It is also unnecessary in most instances and at times coupled with danger.

3 Pyeloscopy, advocated in this country by Manges, and in Paris by Legueu, though satisfactory when practised by

them, is, in most hands, very unsatisfactory and unreliable, besides involving unnecessary exposure of the fluoroscopist.

4 The coating of non-opaque renal and ureteral stones with the injection of 2 per cent collargol and its subsequent aspiration has been shown to be unsatisfactory in the majority of cases.

5 Arteriography (introduced by De Santos), is the injection of sodium iodide into the aorta, thus outlining in addition to the abdominal vessels the renal arteries. It is considered by most urologists not only superfluous, but formidable and dangerous as a procedure.

6 Visualization of the seminal vesicles by means of injection of opaque media through the ejaculatory ducts has in most instances been difficult and not entirely helpful.

On the other hand, the following procedures which have withstood the test of time are worthy of detailed consideration.

1 *Cystography*—This is a procedure which is used with the aid of both opaque solutions and air for the visualization of the diverticula, bladder stones, bladder tumors, prostatic conditions, and vesico-ureteral reflux. The following technic was employed and proved satisfactory: the bladder is filled through a catheter with a 3 to 5 per cent sodium iodide solution to the point of discomfort to the patient. Exposures in the anteroposterior and oblique or lateral positions are made. The bladder is then emptied and filled again with air and another anteroposterior roentgenogram is obtained. In cases of suspected vesico-ureteral reflux, an additional film is made in the trendelenburg position.

2 *Pyelography*—A 12 per cent solution of sodium iodide or a 15 to 20 per cent solution of any of the organic iodides—iopax (uroselectan), neo-iopax, skioldan, neo-skioldan, or the newly developed compound, sodium ortho-iodohippurate (Swick)—is carefully injected through the ureteral catheter either by gravity or cystoscopically under vision until the patient complains of a fullness in the flank or the indigo carmine stained medium is visual-

ized at the meatus. Roentgenograms are made. Another is taken while withdrawing the catheter and simultaneously injecting the solution in order to obtain a uretero-pyelogram. The latter enables one to visualize both the condition of the ureter as well as negative shadows caused by non-opaque stones, tumors, blood clots, etc. Finally, in specified cases, an additional exposure is obtained after the catheter is withdrawn and the patient has been in a sitting position for ten minutes in order to determine trapping of the renal pelvis, as occurs in cases of aberrant vessels at the uretero-pelvic junction and in ptosis of the kidney. In performing a pyelogram, an attempt should be made at avoiding pyelovenous backflow—the forcing of opaque fluid into the veins overlying the fornices—and “*Büschelbildung*” (tuft-formation), the forcing of the pyelographic fluid into the collecting tubules. The pressure at which pyelography should theoretically be carried out, should accordingly not exceed the renal intravenous pressure. The importance of pyelovenous backflow and “*Büschelbildung*” arises from the difficulty introduced into the interpretation of the roentgenograms, particularly their differentiation from the pyelographic appearance in renal tuberculosis and renal neoplasms.

Retrograde pyelography is considered contra-indicated in the presence of acute urinary infections. In most institutions bilateral pyelography, at one sitting with the inorganic iodides, is not performed. The dangers associated with this procedure may be shock, infection, general sepsis, chemical poisoning, and local irritative phenomena.

THE DEVELOPMENT OF THE ORGANIC IODIDES AND THEIR PRESENT RÔLE IN UROGRAPHY

Beginning with the original contribution of one of the authors (Swick) with iopax (uroselectan) for excretion urography, stable organically bound iodides have come into practical use as urographic media. Subsequently, neo-iopax (uroselectan B),

skiodan, and neo-skiodan have been presented. One of the disadvantages to all of these is the cost of the dye. The organic iodides as a group appear to have been the least irritating to the patient without affecting the density of the shadow for bilateral retrograde pyelography.

To overcome certain obvious drawbacks, such as the large volume and dose, and the expense associated with the use of iopax (uroselectan), one of the authors (Swick) has developed a new organically-bound iodide compound which is here presented in greater detail. This substance, sodium ortho-iodohippurate, has, as a fundamental concept, the use of a normal product of metabolism as a nucleus for the iodine component necessary for roentgenologic visualization. In other words, it is the iodine derivative of a substance normally found in the human urine. For a more detailed consideration of the physiologic principles underlying the development of this substance the reader is referred to previous reports (1). The substance has met the necessary requisites for urography and has proven itself clinically adaptable for intravenous and oral excretion urography as well as for retrograde pyelography.

Sodium ortho-iodohippurate, a neutral salt, contains 38.8 per cent of iodine in stable organic union and is prepared as a white powder which is easily soluble in less than its own weight of water. The solution is prepared in sterile ampoules and remains unaltered, ready for use. The tolerance for the compound is good, and no unfavorable reactions, such as iodism, injury to tissues, or abnormalities in the urine, have been observed. Normally, from 90 to 95 per cent of the substance is excreted unchanged within eight hours after the intravenous injection.

PROCEDURE FOR INTRAVENOUS UROGRAPHY WITH SODIUM ORTHO-IODOHIPPURATE

Satisfactory urograms have been obtained in adults with doses varying from between 10 to 15 grams of substance in 50

per cent concentration (dose advocated, 12 grams in 25 c.c.). Children have received 10-gram doses (20 c.c.) without ill effects except for occasional transitory nausea and vomiting. The solution should be injected over a period of from three to five minutes. In the routine case the first film is taken ten minutes after the injection and two subsequent ones at from fifteen- to twenty-minute intervals. Later exposures should be made in cases of non-visualization or late visualization. The only complaint registered during and for a few minutes following the injection is generalized warmth. On the completion of the injection, compression is applied and left undisturbed throughout the period of the three exposures.

PROCEDURE FOR ORAL UROGRAPHY WITH SODIUM ORTHO-IODOHIPPURATE

To date, this substance is the only one on record to have yielded a high percentage of gratifying results from 10 to 15 grams dissolved in approximately 75 c.c. of a mixture of simple syrup and elixir lacto-peptone have given suitably diagnostic radiograms. The only subjective sensation recorded is the salty aromatic taste of the solution. Nausea or vomiting has not occurred. Satisfactory results were obtained approximately from 60 to 135 minutes after administration. The patient is placed upon the x-ray table 45 minutes after the ingestion of the solution. A moderate degree of compression is applied over the urinary bladder region and x-ray exposures are made from 60, 90, 120, 150 minutes after the oral administration of the dye.

The Use of Compression—We are convinced that, in order to consistently obtain clearly defined urograms, a moderate degree of compression over the region of the urinary bladder by means of an air-inflated rubber bag is quite essential. The balloon is held in place in the midline by means of the canvas-compression band, and left undisturbed during the x-ray examination from the time of the completion of the

injection The opinion held by some that compression produces an artificial dilatation of the urinary tract has not been confirmed by our experiences

conditions are preferably investigated by the excretory rather than by the retrograde route The non-visualization of the urinary tract viewed together with the com-

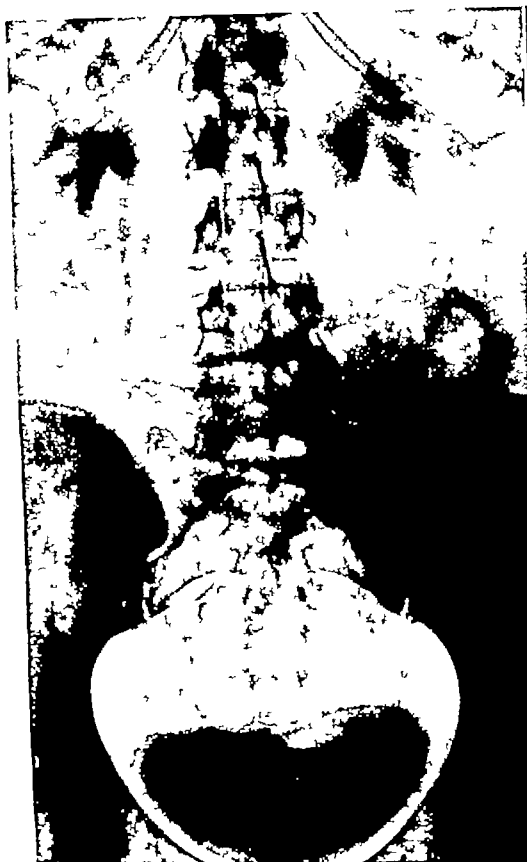


Fig 5 Intravenous urogram in a case of uretero pyelo-nephritis, showing dilatation of both urinary tracts more marked on the right side, with angulation at the uretero-pelvic junction



Fig 6 Oral urogram, same case of uretero pyelo-nephritis for comparison with intravenous result showing dilatation of both urinary tracts more marked on the right side with angulation at the uretero-pelvic junction

Indications —In general, indications for excretory urography are evident in all cases in which retrograde pyelography is recommended, and particularly when the latter procedure in the presence of infection or mechanical difficulties is contra-indicated. Such mechanical difficulties may be hematuria, cases of reimplanted ureter, cases of anomaly, children, individuals in whom instrumentation is taxing and dangerous, and obstructive lesions such as stones, strictures, and neoplasms. Cases presenting obscure abdominal symptoms and

posite clinical picture can of itself be of great assistance in the localization of the disease and in establishing the diagnosis.

Contra-Indications —Excretory urography is of no value for anatomic diagnosis in cases of uremia or latent uremia. Under such conditions the injection of any substance may be an accompanying or contributing factor to exitus. On the other hand, to determine the renal function simpler and cheaper methods may be resorted to.

RETROGRADE PYELOGRAPHY WITH SODIUM ORTHO-IODOHIPPURATE

Solutions in from 15 to 20 per cent concentration have given satisfactory bilateral retrograde pyelograms at one sitting without untoward effect to the patient

Without entering into a detailed account pertaining to the various aspects of renal function in its relationship to excretory roentgenologic visualization, it should be strongly pointed out that excretory urography, in contra-distinction to retrograde pyelography, which is purely a mechanical, non-physiologic filling of the pelvis and calices, is excretory in nature and, therefore, dependent upon renal and extra-renal variations. *In order to avoid repetition*, the reader is referred to earlier publications for such important considerations concerning excretion urography as, for example, renal function and excretion urography, renal function and radiologic findings in hydronephrosis, temporary functional inhibition, and non-visualization as an aid in localization of the disease and in establishing the diagnosis

CONCLUSIONS

Urography represents a notable advance in the science of medicine. Its claim to

recognition as a science strongly rests upon the precision, accuracy, and rational thinking that it adds to diagnosis. The fact that excretion urography, since its development upon broad practical principles, has been a definite and invaluable contribution is not challenged. Excretory and retrograde pyelography should complement and supplement one another. One's attitude should be that of employing both methods intelligently and to the best advantage, rather than focusing one's attention on which of the two procedures is the better. In our experience we have found excretion urography to be in general useful, and in particular, where retrograde pyelography is contra-indicated because of the presence of infection or mechanical difficulties. Similarly, retrograde pyelography is essential in corroborating or supplementing the equivocal results of excretion urography.

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BULLOUS EMPHYSEMA(?) OR BILATERAL PNEUMOTHORAX(?)¹

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ACKNOWLEDGMENT

WE are prompted to write this article because of a paper entitled "Chronic Bilateral Spontaneous Pneumothorax" recently published by Joseph Lewis (1). Lewis describes a case in which the clinical and x-ray findings justified a diagnosis of chronic bilateral spontaneous pneumothorax. He made an exhaustive search of the literature and was unable to find a like case. We have had the privilege of observing two such cases, in the first one we made a diagnosis of bilateral pneumothorax, but after further experience with the second case, after familiarizing ourselves with the physiologic factors concerned, and after a review of the literature, we came to change the diagnosis to that of bullous emphysema. The experiences of Haahti (2) proved especially illuminating to us in this respect.

Physiological Considerations—The laws governing the diffusion of gases in a closed body cavity are such that a closed pneumothorax cannot persist without marked contraction of the affected side of the chest. When the spontaneous pneumothorax first occurs, the partial pressure of the gases in the cavity is the same as that in the atmosphere and much greater than that of the gases in the blood and tissues. There immediately begins a diffusion of the gases from the pneumothorax into the blood, with a progressive drop of pressure in the pneumothorax cavity. Only after the pressure drops to about 95 cm of water below atmospheric pressure will there be an equilibrium established so that further absorption will not occur (3). As a result of the low pressure in the pneumothorax, the overlying chest wall is compressed

and the abdominal viscera are crowded upward by the atmospheric pressure. In the cases reported by Lewis and Haahti as well as in our own two cases, there were no signs of contraction of the chest, and the pressure in the air chambers was not much below atmospheric. These findings alone are sufficient to rule out pneumothorax. Even open pneumothorax leads to contraction of the chest unless the outside opening be larger than the glottis, which is hardly compatible with life. Moreover, an open pneumothorax invariably becomes infected and fluid develops in it. In the cases under discussion, there were no symptoms of sepsis and no fluid in the air chambers.

Lewis' Case—A man aged 49 years had been developing increasing dyspnea for 7 years, and had been treated for asthma. There was hyperresonance over the upper lobes and no vesicular breath sounds. The x-ray appearance resembled closely that of our Case 1. There were no lung markings above the level of the third anterior rib on each side, suggesting bilateral pneumothorax. However, collapsed lungs do not show at the lung roots, and there can be seen no line of separation of the lung from the chest wall. A film made five days after the first examination showed the air chambers to be much larger, reaching down to the fourth rib on each side, yet there was no separation of the lower lobe from the chest wall. A manometer needle was introduced into the air pockets and the readings were plus 6, minus 2 on the left side, and plus 4, minus 2 on the right side. These readings plainly showed that the needle was in the lung tissue communicating with a bronchus and not in the pleural cavity. The patient died a few hours after the paracentesis, apparently due to a "superimposed acute pneumothorax" caused by the needle

¹ Published with the permission of the Medical Director of the Veterans' Administration who is not responsible for the opinions expressed by the authors.

puncturing the lung Lewis remarks "Examination of the radiograms shows that the combined collapse would not be equivalent to a complete unilateral pneumothorax, yet why the marked dyspnea?"

Haaliti's Case—The patient was a youth aged 19 years, who had no complaints referable to the lungs. He had hyperresonance and absent breath sounds over the right upper lobe, and the x-ray film showed no lung markings over the upper half of the right lung, nor was there seen a collapsed lung. The exploring needle first entered the pleural cavity, the pressure having been found normal (minus 12). The needle was then deliberately inserted into the lung in which the abnormal air cavity was found. Pressure was minus 5 in inspiration, and minus 3 in expiration. After the aspiration of 750 c.c. of air, the pressure remained unchanged, which was interpreted to show that the communicating bronchus had a valve opening. The punctures resulted in a pneumothorax also in this case. Following the establishment of the pneumothorax, an x-ray film showed beyond any doubt that the original air cavities were in the lung proper.

Case 1—The patient was 35 years of age at time of the examination. He had had fair health in childhood but could not indulge in any sports because of short-windedness. He served in the Army from March, 1918, until November, 1923, his duties in the service not being of a very strenuous nature. After his discharge from the service he found the civilian occupations too laborious. There was increasing fatigability and shortness of breath on exertion. He had been unable to work gainfully in the past four years. He began to seek medical attention in 1929. At that time he had pains in the chest on exertion related to deep breathing. After exertion he would become breathless and pain would appear on each side of the breastbone, worse on the left side. He learned to remain quiet and to breathe as lightly as possible for fifteen or twenty minutes, the pains would then subside. More recently, the pains and shortness of breath

had occurred without much exertion. There was no fear of death during the pains and no radiation of the pain down the arms. There was much cough and orthopnea at rest, and a gradual loss of some 40 pounds in weight.

The man was poorly nourished, weighing 117 pounds. He was dyspneic when active and occasionally cyanotic. His temperature was normal. Respirations varied between 20 and 50 per minute. His heart was normal. His chest was short, broad, and flat, the clavicles being rather prominent. The upper chest did not expand, the lower chest expanded well. There was no tactile fremitus over the upper lobes. The percussion note anteriorly over the upper thorax was high-pitched, tending to be tympanitic. The breath sounds were absent over the upper half of the chest both anteriorly and posteriorly. The vital capacity was 2.6 liters, while the estimated capacity was 3.8 liters. The manometer needle entered the pleural cavity on each side. The pressure found was minus 2 to minus 8 cm. of water on the right side, and minus 6 to minus 10 on the left side. The lung was apparently not punctured and there were no untoward results. We believe that the abnormal air spaces were not entered by the needle.

The chest specialist remarked: "These pressures are not highly negative. In pneumothorax of long duration the pressure becomes much more highly negative. In this case there has been no marked absorption of air, and if this had occurred the remaining portions of the lung would have been drawn up into the upper thorax so that the lines visible in the lung would have their convexity upward rather than downward as at present. One of the striking facts is the absence of chest deformity. All that we know in this case is that the pneumothorax has been present since 1930. It is difficult to say why the air has not been absorbed in the intervening two years. This can be explained upon one of three bases. The first is that the pleural surfaces are thickened and absorption abnormally slow, this is not



Fig 1 Case 1 Bilateral pneumothorax or apical emphysema(?) see text



Fig 2-A Case 2 Progression of bullous emphysema On Sept 16, 1930, there are no normal lung markings in either apex There is a large emphysema bleb in the left apex its lower border showing just below the clavicle The three blebs in the right apex are separated by thickened septa

probable The second is that there is a persistent fistula if this were the case, fluid would certainly be present and probably secondary infection The third explanation is that as the lungs re-expand, the breaks in them are reopened and they again drop down I have seen cases in which a lung has repeatedly partially expanded and then recollapsed It is unlikely, that this rather rare occurrence would happen in both sides in this case "

The roentgenologist submitted the following report "We have a massive pneumothorax in both apices, extending down to the sixth interspace posteriorly on the right, and to the eighth on the left, extending anteriorly to the third on the right, and the fourth on the left Below these zones we see lung tissue, apparently normal on the right but with abundant pleural adhesion on the left I cannot see where the upper lobes have retracted to One would expect at least a small rounded

shadow at the lung root representing the contracted upper lobe on both sides I see no evidences of disease in the lungs to account for this type of pneumothorax I do not see enough evidence of pleural adhesions to explain why the pneumothorax is limited to the upper part of the chest I suppose the pleura must be adherent "

It will be observed that both the clinician and the roentgenologist were not quite satisfied with the diagnosis of bilateral pneumothorax, and for good reason there was no pneumothorax.

Case 2 —The man was operated on for gangrenous appendicitis, in 1922, at the age of 25 He was said to have ether pneumonia The convalescence was slow and he had a chronic cough He has been examined periodically during the past twelve years Tuberculosis was suspected but the diagnostic signs of pulmonary tuberculosis (*i.e.*, tubercle bacilli, moist râles, or typical x-ray shadows) were not



Fig 2 B On Oct 29 1933 the bleb in the left apex has enlarged and its visible border is lower in the chest. In the right apex the blebs are also larger although but one septum persists (confluence of emphysema vesicles by rupture of septum)

Fig 2 C Film taken in expiration at the same sitting as B. The lung bases are deflated but there is increased inflation of the emphysema vesicles (paradoxical breathing)

Fig 2-D Film taken in knee chest position at same sitting as B and C. Lung markings are now visible in the apices. Note the great transparency of the lung bases in this position.

demonstrated. In February, 1923, an x-ray examination of the chest was reported to show "some increased density in the extreme right apex slightly mottled in character, infiltration in right apex very suspicious of an early tuberculous lesion."

On Jan 9, 1924, the roentgenologist reported "The pulmonary markings extending up into the apices are granular and in the right apex there is a patch of webby shadow."

It must be assumed that, in 1924, there were lung markings in the apices. On Aug 6, 1924, "both apices showed coarse mottling." On Feb 29, 1928, the case entry reads "Appears to have some small mottling in both upper lobes and near the apices." In September, 1930, the physical examination showed feeble breath sounds over the apices. The x-ray film (Fig 2-A) showed a dense line running across the left upper lobe with no lung markings above this line, this was interpreted as a large emphysema bleb, the dense line being its thickened base. The right apex likewise showed no normal markings but there were two dense vertical lines representing thickened walls of emphysema blebs.

In November, 1933, the physical signs

were unchanged. The x-ray film showed an increase in the air chambers in the two apices. On the left side the dense line has moved down perceptibly. In the right apex only one of the vertical lines persisted, the other line disappeared, presumably due to rupture and confluence of the emphysema vesicles. An x-ray film made in expiration showed enlargement of the apices, with increased air content. A film made in the knee-chest position showed the appearance of lung markings in both apices.

DISCUSSION

Bullous emphysema is associated with strictures along the course of the bronchi (4, 5), during inspiration the bronchial lumen enlarges to admit air, during expiration the lumen about the stricture is obliterated, so that there results an obstructive emphysema. The expiratory enlargement of the emphysema blebs may be observed fluoroscopically (Fig 2). During postmortem examination, compression of the lung causes inflation of the blebs. During labored breathing, as after exercise or excitement, there occurs an air exchange between the normal and emphysematous

areas (6) as well as between the normal lung and the atmosphere, the stale air from the emphysema blebs may reach the normal alveoli in advance of the atmospheric air, thus adding to the respiratory distress. The attacks of dyspnea and cyanosis observed in Lewis' case and in our Case 1 thus find explanation, also the fluctuating size of the air chambers in Lewis' case. But for this paradoxical breathing one would not expect much dyspnea in these cases, as the apical regions of the lung normally participate but slightly in respiration. Extensive tuberculous infiltration may exist in these regions without causing dyspnea.

Differential Diagnosis—The physical signs are very similar in emphysema and in pneumothorax. The x-ray appearance may also be inconclusive. In apical pneumothorax there is no lung to cast the typical x-ray shadows, in emphysema the blood vessels which are responsible for these lung markings are very small in films made in the usual manner, *i e*, with the patient standing or sitting. In the erect position, the blood vessels in the lung bases are engorged, the apices being relatively ischemic so that they appear very transparent as compared with the lung bases. In apical emphysema, due to the poverty of blood vessels typical of this condition, no markings may show on films made in the erect positions. In these cases a film made in the knee-chest position helps to establish the diagnosis. In apical emphysema lung markings appear in the knee-chest films, in pneumothorax

or tuberculous cavity, complete radio-lucency persists (Fig 2)

SUMMARY AND CONCLUSIONS

1 Bullous emphysema can closely simulate partial pneumothorax.

2 In a given case, if the condition is of long duration the diagnosis is in favor of emphysema rather than pneumothorax.

3 Retraction of the chest wall and of the viscera points to pneumothorax, absence of retraction points to emphysema.

4 Bullous emphysema is generally associated with bronchial strictures which have a ball-valve action. The emphysema blebs are larger on films made in expiration.

5 If the x-ray film is taken with the patient in the knee-chest position, lung markings appear in the emphysema blebs, in apical pneumothorax the lung markings remain absent in all positions.

6 Investigation of the intrathoracic pressures with a needle is fraught with danger in these cases, and is not likely to furnish diagnostic information.

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NEW DEVICE

THE CORPIOMETER¹

A CONTOUR GAUGE FOR OBTAINING CROSS-SECTION BODY OUTLINES

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In order to accurately estimate the proper roentgen dosage that is to be delivered to a deeply seated lesion by high voltage x-ray irradiation, it is necessary to know definitely the size and shape of a cross-section of the body at the level in which the lesion to be treated is located. Several methods of obtaining such information are in common use, such as measuring the diameters in sagittal and transverse planes, the use of lead wires to obtain an outline, etc. Thinking that perhaps some method

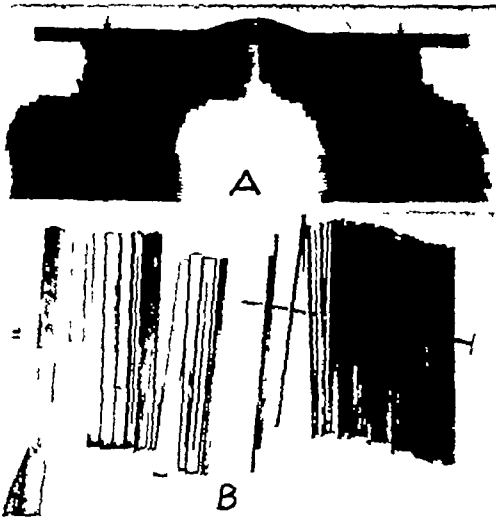


Fig 1-A Gauge, after having been adjusted and removed

Fig 1 B Thumb nut removed from iron rod and later withdrawn from about half of the strips. Some strips are turned, to show grooves, tongues, and slots

could be devised whereby the outline of the body at any desired level could be quickly and accurately determined, a mechanical engineer was consulted. He suggested using a modification of the contour gauge.

Accordingly such a gauge was designed and made. It consists of two similar parts hinged together so that they can be quickly adjusted and removed from the patient's body. Each

part in reality consists of a single contour gauge made up of 46 wooden strips placed one upon the other to a height of 11 inches. These strips are slotted through the center. An iron rod traverses all of the slots and passes through a hole the same size as the rod, that has been bored through a heavier piece of wood which is longer than the strips and acts as the top and a handle. The end that passes through the handle is threaded and fitted with a thumb nut. Thus by a few turns of the thumb nut the strips of wood can be securely fastened in position or loosened so that they move freely backward and forward. Each piece of wood measures $11\frac{1}{2} \times \frac{3}{4} \times \frac{3}{8}$ inches. One side contains a groove $\frac{1}{8}$ inch in depth, the other side a tongue $\frac{1}{16}$ inch thick, the tongue of one fitting into the groove of the other. This allows free movement in one direction and prevents side movement when the thumb nut is loosened.

In order to obtain the outline of both sides of the body at one time, these two sets of wooden strips are joined together by a hinge. This allows the convex side of the body to be measured and the gauge removed without disturbing the strips of wood.

Figure 1-A illustrates the gauge as it appears after having been adjusted to a patient and removed. The handles are at the top of the illustration. The thumb nuts can be plainly seen on the upper border at the middle of each handle. The strips of wood, one above another, give a laminated appearance to the gauge. The space in the center of the corpiometer represents the outline of the patient's body.

In Figure 1-B, the thumb nut has been removed from the iron rod and the latter withdrawn from about half of the strips of wood. Some of the strips have been turned so that the grooves, tongues, and slots can be seen. In order to facilitate the sliding movement of the strips upon one another they have been sanded and papered and fitted to each other carefully and a thin coating of paraffin applied.

In Figure 2, the different steps in its use are illustrated. A shows how the gauge is placed around the part of the patient to be measured. The strips have been adjusted to conform to the outline of the body and the thumb nuts, which were previously loosened so as to permit free movement of the strips, have been tightened, thus fixing the strips in the position which conforms to the outline of the body.

In Figure 2-B, the gauge is being removed. The one side is being lifted upward while the other side remains in position. This is accomplished by bending one side upward and backward toward the other through the intermedi-

¹ Received for publication April 26 1934

ary of the hinged joint which fastens the two handles together

In Figure 2-C a tracing is being made on thin semi-transparent paper of the space which represents a cross-section of the body, the gauge

The device has been in constant use for about six months. With it, much time is saved and it has been found so far superior to any other method hitherto employed by us that it was thought perhaps others might find its use

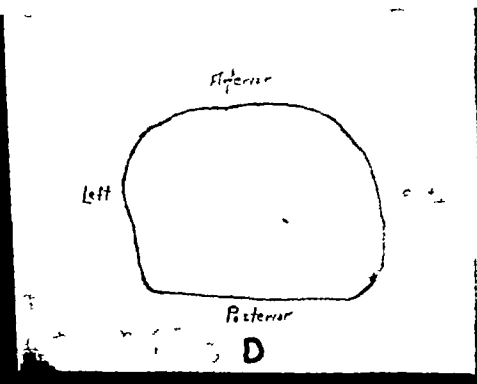
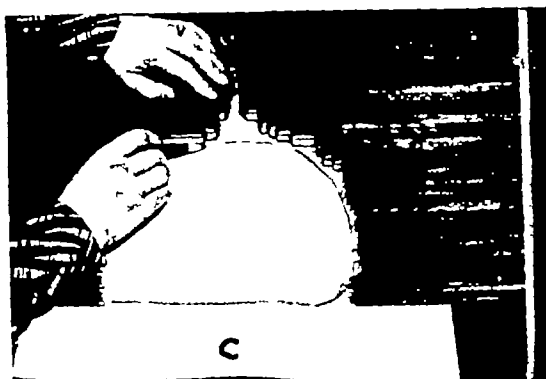


Fig 2-A Gauge on body of patient

Fig 2-C Tracing being made on thin paper

Fig 2-B Gauge being removed.

Fig 2-D Tracing placed upon isodose chart

having been placed on the paper with the laminated strips in the exact position they held when adjusted to the patient. The outline thus obtained accurately portrays both the size and the shape of the body at any particular level. The paper with the outline traced upon it is then placed on isodose charts, as in D, and estimates as to dosage made

just as advantageous. There are no complicated parts to get out of order, one can learn to use it without instruction, no accessories such as charts, cuts, or lantern slides are needed, and an accurate outline of a cross-section of the body at any desired level can be obtained with the patient in any position.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

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SELECTION, EDUCATION, AND SUPERVISION OF X-RAY TECHNICAL WORKERS

When the x-ray first came into use, each person working with the particular equipment at his disposal, developed his own personal plans and technic. This was necessary because of the great variation in the poor equipment then in use.

With the developments of radiology a new and entirely unique problem confronts the medical profession. This problem develops because of the highly specialized technical and scientific procedures that are necessary to do useful x-ray work in both diagnostic and therapeutic lines. With the vast amount of x-ray work being done and the demand for economic services to the patients, it is impossible for the radiologists to personally do this technical work. Likewise, surgeons or physicians practicing other specialties of medicine cannot properly do x-ray technical work because of their lack of knowledge and of training in x-ray activities, and likewise because they do not have the time to properly do x-ray work in conjunction with successfully carrying on their other professional work. Then, too, in spite of the high-pressure salesmanship of the x-ray concerns, physicians in general practice are coming more and more to realize that it is a financial waste for them to put in x-ray equipment, pay the rent on the necessary extra space that this equipment would occupy, and carry on the over-head expense of maintaining such equipment in conjunction with their regular lines of professional work.

For these and other reasons, it is now quite generally understood and agreed upon that there must be a distinct class of technical workers, commonly designated as x-ray technicians, to do this necessary technical work included in the x-ray activities of the present. Experience has proven that it requires a higher degree of intelligence, a higher degree of mechanical skill, and especially a more stable temperament to successfully meet the duties devolving upon the x-ray technician than are required of a registered nurse.

The medical profession, therefore, is confronted with the problem of the selection, education, and supervision of this new and extensive group of technical workers who have become a necessary adjunct to the practice of medicine.

It goes without saying that the surgeons should select and control the training of surgical nurses. In like manner no one but the experienced roentgenologist is capable of controlling and directing the selection, training, and activities of the x-ray technical workers.

All new medical discoveries and activities have been seized upon by impostors and quacks of all kinds to be exploited for their commercial benefit. The x-ray has been no exception to that rule. The rather large number of "commercial" x-ray laboratories still in existence is a dangerous menace to the welfare of the patients sent to such laboratories by physicians who are not fully informed of the dangers of such procedures, or by certain other physicians whose standards of ethics permit them to make dishonest financial arrangements with these "commercial" laboratories, always to the detriment of their patients. This is a standing disgrace and menace to the public.

It follows that these technical workers should be carefully selected and trained in proper institutions where a definite standard course of training can be maintained. They should be supervised by roentgenologists of recognized standing. These trained workers should be so registered and organized that they will be under the control of the medical profession. They should be particularly under the control of the specialists in the medical profession who are competent to look after the x-ray activities of the practice of medicine. To this end, an examining and registration board, composed of properly selected roentgenologists and possibly some other members of the medical profession, which should function for the entire North American continent, affords the most practical basis of control. The x-ray technical workers should be ex-

amined and found worthy and qualified to be registered as such technical workers, and then organized into a national society or association as one of the necessary requisites for improving themselves. This national organization would both promote the proper spirit of organization and development of said technical workers, and also keep them under the direct control of the examining board above mentioned. Of course, to make this fully binding, there should be a requirement of annual renewal of their certificate for the practice of technical work issued by said Radiological Technicians Examining Board. The fees for these examinations and reissuance of certificates need not be at all excessive. A merely nominal fee of five dollars for the original examination, and a fee of about two dollars for each renewal certificate annually would probably cover all the costs of conducting this work and would not in any way be a hardship upon the x-ray technical workers.

It is quite certain that if any state or any small municipal government be allowed to assume any regulation as to the selection, education, examination, and registration of these x-ray technical workers, petty politics and political graft and incompetency will at once creep into all such state or other local attempts to register and regulate their activities. This would be a dangerous menace to the medical profession and to their patients.

As organized at present the Radiological Society of North America provides a Registry Board for the examination and registration of the workers in the field of radiographic technic. This Registry Board imposes certain conditions upon the applicants for registration. Among these conditions are the following. The technician must work under the supervision of a qualified radiologist, the technician must limit his work in radiography absolutely to the technical application of x-rays. Certain restrictions are also placed upon the ethics of the technical workers. The x-ray technicians have a national organization known as the American Society of X-ray Technicians, numbering between 450 and 500 members, which is functioning and co-operating with the radiologists and roentgenologists throughout the country. Affiliated with the national organization are local organizations of technical workers located in the larger centers of population and fairly well distributed through-

out the country. The national organization has a Council appointed by the President of the organization and composed of members of the national technical organization and also having as members three or more radiologists, members of both the Radiological Society of North America and the American Roentgen Ray Society. The duties and functions of this Council are to promote educational projects that will help to increase the efficiency of the technical workers in x-ray and also to co-operate with the Registry Board of the Radiological Society of North America to the fullest extent in all things tending to help the interests of radiography and to increase the efficiency of the x-ray technician.

The American Society of X-ray Technicians solicits the co-operation of the radiologists and roentgenologists of the country in helping to place the work of the x-ray technicians of the country at the highest level of scientific attainment in the field of x-ray technic.

The American Registry of Radiological Technicians of the Radiological Society of North America with the co-operation of the Council of Education and Registration of the American Society of X-ray Technicians has approved a standard course of training and instruction, the length of time of which is one year. This length of time in training will very probably be increased to two years in the very near future. This standard course of training is given by institutions approved by the American Registry of Radiological Technicians of the Radiological Society of North America.

It is hoped that in the near future one of the requirements for a Class A Hospital may be that the x-ray technician in charge of the technical work in the x-ray department of said hospital shall be a Registered X-ray Technician. This said registration would certify that the technician had a standard course of training and instruction, had passed the tests of the American Registry of Radiological Technicians of the Radiological Society of North America both in theory and practice, had a sufficient time of experience in technical work, and was fully qualified in that branch of medical science.

This qualification of x-ray technicians covers the entire territory of both United States and Canada.

It will thus be seen that the training and regulation of the x-ray technicians is fairly

well organized and supervised at this time. It is hoped that all medical organizations will be in sympathy with this movement and co-operate with the various roentgenological and radiological organizations to place the personnel and efficiency of the x-ray technicians on the highest plane possible.

COMMUNICATIONS

PROGRAM OF THE ANNUAL MEETING

The following tentative schedules are offered to our readers thus far in advance of the date of the Annual Meeting, by their originator, Dr W H McGuffin, with the thought of giving an outline of the character of the Scientific

Sessions. No doubt program arrangements will change as the plans mature and the number of papers to be presented increases, but at present they serve to give one an idea of the classifications under which the presentations will likely be grouped. At any rate, it does not leave matters to chance and the prospective essayists to speculation, such changes as seem needful will be made later in the year. Constructive suggestions are invited.

The program is rapidly taking form. The division of Diagnosis is under the leadership of W W Wasson, M D, of Denver. A symposium on Silicosis is being arranged by E C Ernst, M D, of St. Louis, a symposium on Arthritis by H P Doub, M D, of Detroit, a symposium on Urography by B H Nichols, M D, of Cleveland, a symposium on Thoracic Neoplasms by J T Farrell, Jr, M D, of

Time	Monday	Tuesday	Wednesday	Thursday	Friday
8 30 to 10 30	Registration and Opening Ceremonies	Silicosis	Arthritis	Buccal Cavity and Neck	Dermatology
10 30 to 12 30	Urology	Thoracic Neoplasms	Physics of Radiation	Breast and Pelvic Viscera	Bone Pathology
12 30 to 2 00	Lunch				
	TECHNICAL AND SCIENTIFIC EXHIBITS				
2 00-2 30 2 30-3 00 3 00-3 30	Gastro-intestinal Tract	Executive Session 'Unification of Societies'	Super-high Voltage	Executive Session "Economics"	Spinal Lesions
	SCIENTIFIC EXHIBITS				
3 30-4 30	Scientific exhibitors 15 minutes each	Scientific exhibitors 15 minutes each	Scientific exhibitors 15 minutes each	Scientific exhibitors 15 minutes each	Scientific exhibitors 15 minutes each
	Clinics	Clinics	Clinics	Clinics	Clinics
4 30-5 00 5 00-5 30 5 30-6 00	See following schedule	See following schedule	Recreation	See following schedule	See following schedule

CLINICS						
Monday and Tuesday						
Time	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6
4 30	Esophagus	Encephalography	Accessory Nasal Sinus Technic and Interpretation	Roentgen Therapy Thyroid Disease	Intravenous Urography	Physical Method of Calculating Roentgen Dosage
5 00	Stomach and Duodenum	Ventriculography	Opaque Oil Visualization Accessory Nasal Sinuses	Roentgen Therapy Breast Pathology	Retrograde Urography	Measurement of Radiation Dosage with Instruments
5 30	Colon	Spinal Canal Tumors	Mastoid Sinus Technic and Interpretation	Roentgen Therapy Uterine Pathology	Hysterosal pingography	Physical Method of Calculating Roentgen Dosage

CLINICS						
Thursday and Friday						
Time	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6
4 30	Heart and Great Vessels	Radium Therapy Oral Malignancy	Examination of Teeth and Interpretation of Films	Roentgen Therapy Spinal Nerves	Radium Treatment Uterine Malignancy	Physical Method of Calculating Roentgen Dosage
5 00	Opaque Oil Visualization of Bronchi	Radium Therapy Breast Malignancy	Salivary Calculi and Sialography	Roentgen Therapy Lymphoblastoma	Radium Treatment of Lesions of Female External Genitalia	Measurement of Radiation Dosage with Instruments
5 30		Radium Therapy for Thyroid Disease	Roentgenography of Larynx with Interpretation of Films	Roentgen Therapy of Skin Diseases		Physical Method of Calculating Radium Dosage

Philadelphia, a symposium on Bone Pathology by R T Wilson, M D , of Temple, Texas, and a symposium on the Gastro-intestinal Tract by B R Kirklin, M D , of Rochester, Minnesota

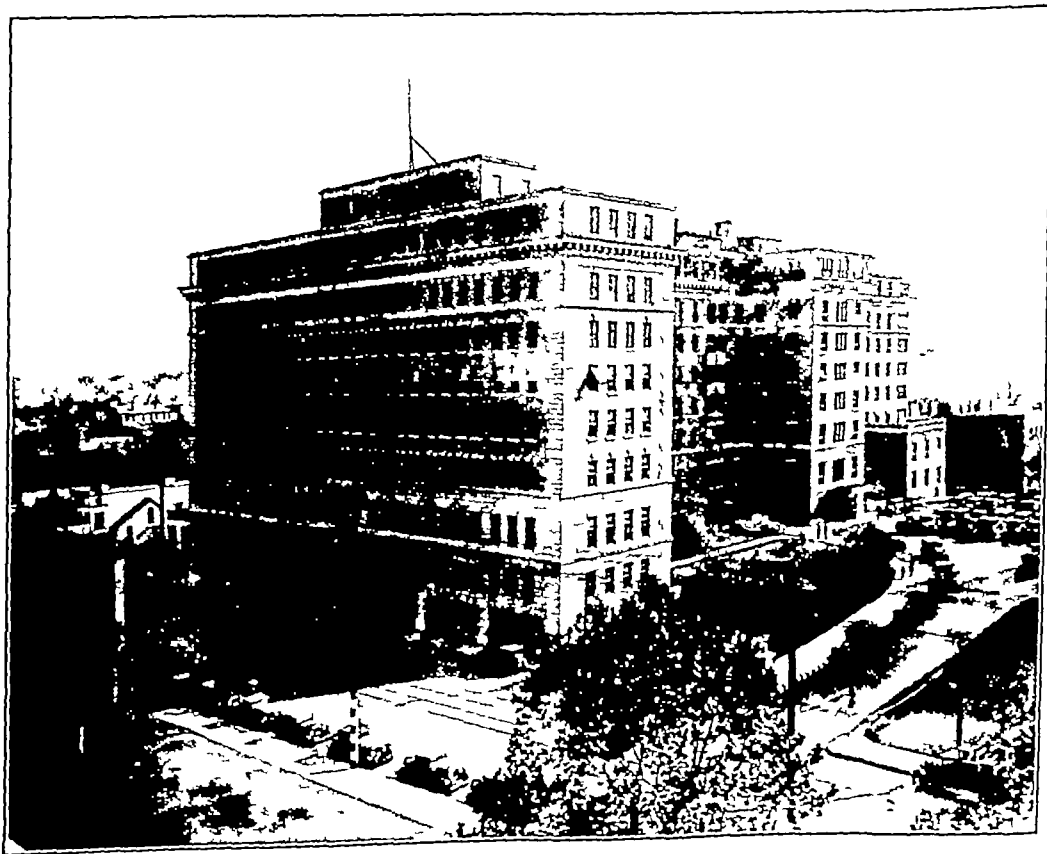
MEMPHIS, THE PLACE OF THE NEXT ANNUAL MEETING

The city of Memphis, Tennessee, where the next Annual Meeting of the Radiological Society of North America is to be held during the week of December 3 to 7, inclusive, is distinguished for the number of fine hospitals, among other features, located there. In presenting a preview of the Annual Meeting to the readers of RADIOLOGY, the Committee of Local Arrangements feels it cannot do better than show photographs of as many of these fine hospitals as possible. From them, physicians can best judge the size of the City of Memphis and its relation to the area of country it serves. In fact, Memphis may be called the City of Hospitals, institutions of which its medical profession may well be proud.

In this issue, we present views of the Baptist

Memorial Hospital, the Methodist Hospital, and the John Gaston Hospital, otherwise known as the New City Hospital. In later issues of RADIOLOGY, as space may permit, we will endeavor to present views of the other Memphis hospitals. It is in these institutions that the clinics which are so important a feature of the program of the Annual Meeting are to be held.

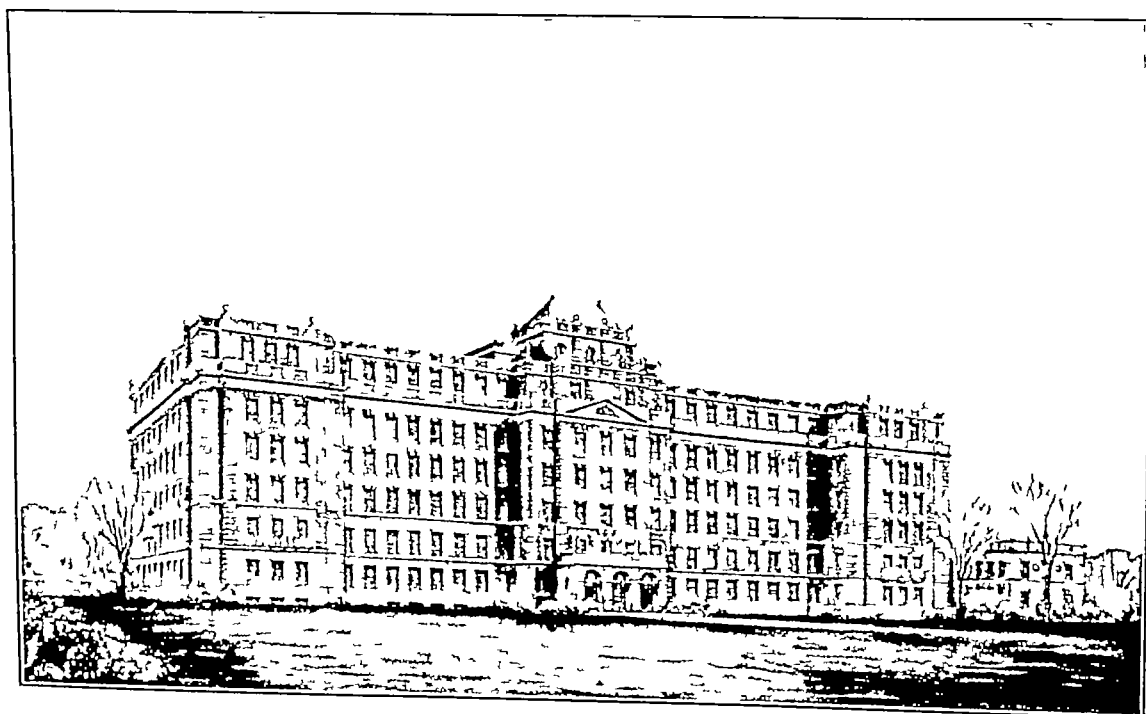
Members of the Society and its guests will be welcome at these institutions during the week of the Annual Meeting and gladly shown their facilities and equipment. The Committee feels that in no other way can radiologists visiting Memphis be so well shown the stage of progress made by radiology in this area of the middle South.



Baptist Memorial Hospital Memphis



Methodist Hospital Memphis



The John Gaston Hospital (New City Hospital), Memphis

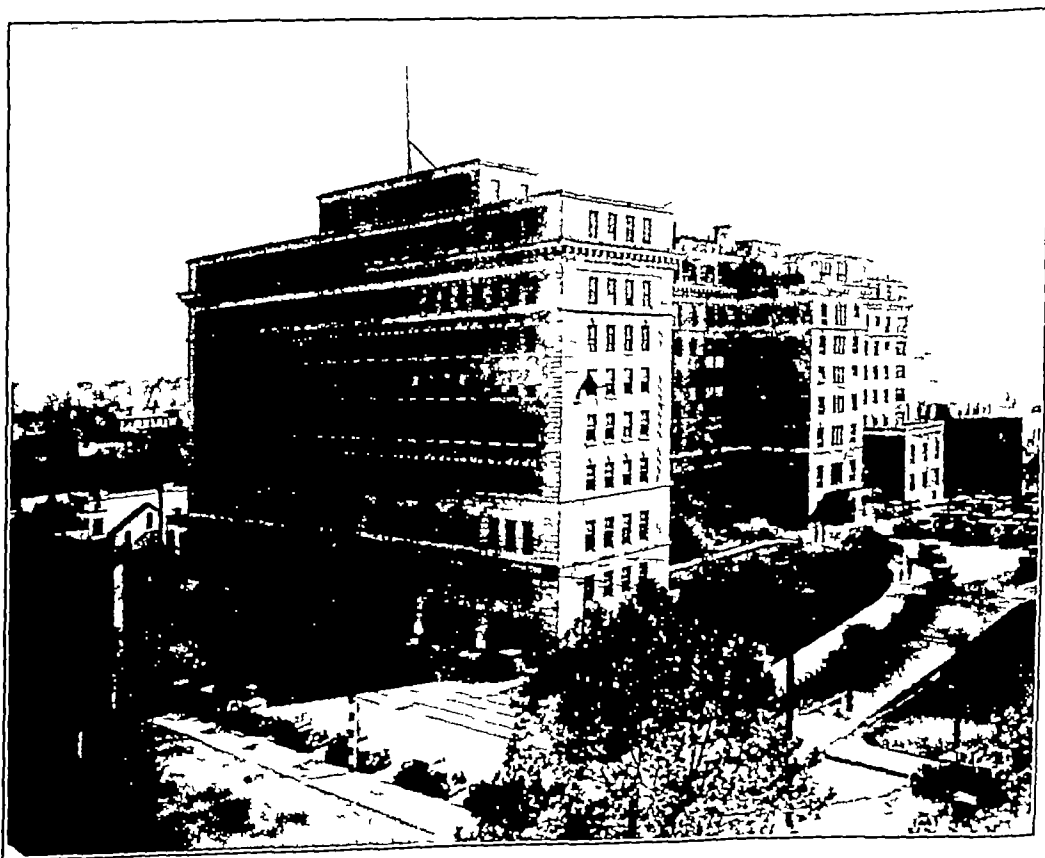
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Baptist Memorial Hospital Memphis

Eastman Kodak Company
 Westinghouse X-ray Company
 General Electric X-ray Corporation
 Standard X-ray Company
 Picker X-ray Company
 DuPont Film Mfg Corporation
 Buck X-Ograph Company
 Philips Metalix Corporation
 George W Brady & Company
 Patterson Screen Company
 H G Fisher & Company

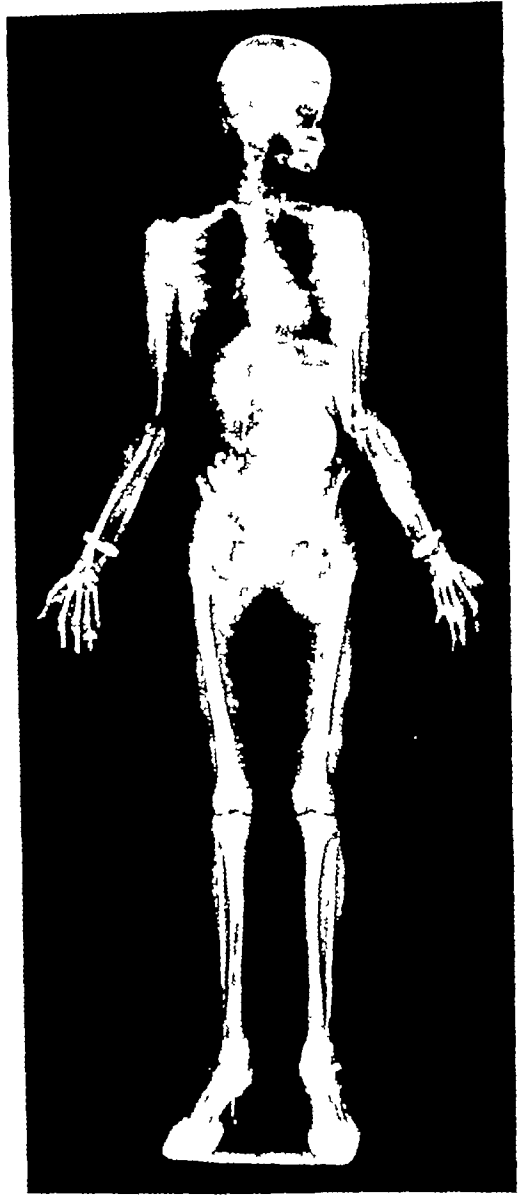
A POPULAR DEMONSTRATION AT A CENTURY OF PROGRESS

Herewith is presented a roentgenogram showing the appearance of an entire *living* girl, aged twenty years. The roentgenogram was made with one exposure, employing a single x-ray film 32 by 72 inches in size. This attractive young lady stepped into the x-ray research laboratory of the Eastman Kodak Company and became the subject of a full-length x-ray portrait. The life-size result, taken in one second on what may be the largest film ever used for an exposure, has just gone on view at A Century of Progress, in the exhibit arranged by the Chicago Roentgen Ray Society.

No doubt the young lady would have preferred dinner, but the technician in attendance was compelled to recommend that she ingest a meal of barium sulphate and malted milk so as to delineate roentgenographically the gastrointestinal tract.

This roentgenogram marks a new departure and should provide a means whereby studies can be made of the relationship between the internal organs of the body and posture, of malignant metastases, of multiple fractures and dislocations, and of the sequelæ of metabolic diseases which manifest themselves in alterations of the skeletal structure. Such roentgenograms should also have value in the medical school in teaching vital anatomy to students.

Full-length roentgenograms can be made in most laboratories. In order to obtain an equalization of density over the subject's entire anatomy, selective filtration of the x-rays is made, employing a copper and aluminum filter.



A full length x-ray portrait

ETHICAL PUBLICITY

Through the co-operation of the Chicago Lighting Institute and the Chicago Roentgen Society a program of education presented to lay persons was given at the Chicago Civic Opera Building during the last two weeks of April. Various members contributed these talks and the total attendance was over three thousand.

Numerous civic and educational bodies were invited, some of which were branches of Ro-

THE ROENTGEN-RAY EXHIBIT AT A CENTURY OF PROGRESS

The opening of A Century of Progress in 1934 found installed in the Hall of Science a rather comprehensive exhibit of x-ray films illustrating the findings in twenty-five diseases selected because of their importance to public health and because of the valuable aid furnished by x-rays in their diagnosis

Such an exhibit was noticeably absent in the Summer of 1933. The whole spirit of showing the lay public the basic factors in disease and the present day of diagnosis is new in the history of medicine. It was the very obvious absence of an exhibit in our newest specialty that prompted the Chicago Roentgen Society to sponsor an exhibit for 1934. Some six hundred films are shown.

The names of the forty radiologists who generously responded to the request for scientific material on the twenty-five diseases selected follow, and the committee preparing the exhibit greatly appreciates their co-operation.

Lewis G. Allen, M.D., Kansas City, Missouri

Robert G. Allison, M.D., Minneapolis, Minnesota

Lewis Gregory Cole, M.D., New York City

Howard P. Doub, M.D., Henry Ford Hospital, Detroit, Michigan

William A. Evans, M.D., Harper Hospital, Detroit, Michigan

William G. Herrman, M.D., Monmouth Memorial Hospital, Long Branch, New Jersey, and Fitkin Memorial Hospital, Asbury Park, New Jersey

Max Kahn, M.D., Baltimore, Maryland

James F. Kelly, M.D., and D. A. McDowell, M.D., Creighton University Medical School, Omaha, Nebraska

B. R. Kirklin, M.D., Mayo Clinic, Rochester, Minnesota

The Jefferson Hospital, Philadelphia, Pennsylvania

Robert R. Newell, M.D., Stanford University School of Medicine, San Francisco, California

Bernard H. Nichols, M.D., Cleveland Clinic, Cleveland, Ohio

George E. Pfahler, M.D., and Jacob H. Vastine, M.D., Philadelphia, Pennsylvania

A. Howard Pirie, M.D., Royal Victoria Hospital, Montreal, Canada

Leo G. Rigler, M.D., University of Minnesota, Minneapolis, Minnesota

Edward W. Rowe, M.D., Lincoln, Nebraska

Frank B. Stephenson, M.D., Children's Hospital, Denver, Colorado

William H. Stewart, M.D., New York City

W. Warner Watkins, M.D., Phoenix, Arizona

Joseph Aspray, M.D., Spokane, Washington
Indianapolis, and Indiana University Hospitals, Indianapolis, Indiana

Children's Hospital, Philadelphia, Pennsylvania

W. E. Chamberlain, M.D., and Barton R. Young, M.D., Temple University Hospital, Philadelphia, Pennsylvania

H. H. Cheney, M.D., Ottawa, Canada

Kenneth S. Davis, M.D., St. Vincent's Hospital, Los Angeles, California

Edwin C. Ernst, M.D., St. Louis, Missouri

Amédée Granger, M.D., Charity Hospital, New Orleans, Louisiana

J. E. Habbe, M.D., Milwaukee, Wisconsin

Charles H. Heacock, M.D., Memphis, Tennessee

Robert H. Lafferty, M.D., Charlotte, North Carolina

Blodgett Memorial Hospital, Grand Rapids, Michigan

Anders P. Overgaard, M.D., Omaha, Nebraska

Dorwin Louis Palmer, M.D., Portland, Oregon

Joseph C. Peden, M.D., St. Louis, Missouri

E. A. Pohle, M.D., Ph.D., University of Wisconsin, Madison, Wisconsin

Charles M. Richards, M.D., San Jose, California

W. T. Rowe, M.D., Rumford, Maine

Wilbur O. Upson, M.D., Leila Hospital, Battle Creek, Michigan

It was agreed beforehand that any or all of the films are to be available for exhibit at the next meeting of the Radiological Society of North America in December. Some of the panels are quite simple and rudimentary, while others are of such character as to interest the advanced student in radiology.

The Chicago Roentgen Society wishes to acknowledge the material aid of the following organizations in making this exhibit possible:

The Radiological Society of North America
The American Roentgen Ray Society
The Chemical Foundation

x-ray operator and the commercial x-ray laboratories constitute a menace to the public and in addition are strictly commercial enterprises conducted by business getters who are actuated by the profit motive and who consequently do not feel themselves bound by the rules of medical ethics but who resort to all sorts of questionable methods to attract a compliant clientele, and

WHEREAS, By the employment of solicitors, runners, and/or other business agents and by the promise of rebates or of favorable or dishonest diagnoses obtain the patronage of unscrupulous physicians or of business and industrial organizations to the detriment of the patient, and

WHEREAS, Because of their illegal activities and the desire for profit they have been unable to attract competent physicians adequately trained in radiology and as a result employ the services of individuals whose education, training, and character are unacceptable to right thinking members of the medical profession or to the American Medical Association, and

WHEREAS, The technical diagnostic and therapeutic advances being made in radiology are due to and dependent on properly trained physicians to whom science must look for further progress in the field of radiology, and

WHEREAS, The lay x-ray technicians and laboratories have so encroached on the practice of radiology that competent and ethical medical practitioners find it more and more unattractive as a field of endeavor, thus endangering the progress and advancement of the science of radiology and the welfare of the public, be it therefore

Resolved, That the House of Delegates in convention assembled believes that the practice of radiology, whether for diagnostic or therapeutic purposes, constitutes in fact the practice of medicine, and be it further

Resolved, That the properly constituted authorities be called on to take the requisite steps to bar all persons not licensed to practise medicine in the State of New York from the practice of radiology, and be it further

Resolved, That, if it is the opinion of the Attorney General that non-medical technicians practising radiology are not violating the law under present conditions, such steps be taken to institute legislation which will include radiology in the practice of medicine and to limit diagnostic or therapeutic x-ray work to the direct and active supervision and control of duly licensed physicians or dentists, and be it further

Resolved, That our delegates from New York to the American Medical Association be in-

structed to bring this matter to the attention of the House of Delegates of the American Medical Association at the impending session

ACTION RELATING TO NON-MEDICAL RADIOLOGISTS

The medical profession of France is to be congratulated on a new law which requires that a radiologist shall be a graduate physician. Those who have been engaged in radiological work for over thirty years are the only exception. The ruling reads as follows

"Radiographers Required to Be Doctors"—A new law pertaining to the practice of medicine will require the possession of a doctor's diploma in order to practise radiography and radiotherapy. Heretofore the radiographic laboratories in the hospitals have been under the direction of specialists who are not graduate physicians. Their number was small, dating for the most part from the beginning period of the use of roentgen rays. Many of these men had adapted themselves to this work in a remarkable manner. Occasionally, however, examples of fraud in the form of 'trick films,' in connection with claims following occupational accidents, have been discovered. Physicians have for some time shown displeasure at the rôle assumed by non-diplomaed radiographers, whom they have charged with a lack of knowledge of anatomy and with not always knowing what part of the body merited particular attention for the establishment of a diagnosis. With regard to treatment, this constituted, it was pointed out, the illegal practice of medicine and entailed serious risks for the patients. As the result of demands made by the medical syndicates, this regulation was inserted in the new law. Non-diplomaed hospital radiologists appointed more than thirty years ago, and who have won the respect of physicians by the meritorious quality of their services, are to be admitted to registration."¹

In Europe as in this country, there have been for years non-medical men and women practising radiology, in private laboratories and even in hospitals where, in certain instances, they have been permitted to take charge of the x-ray department. It is a highly dangerous

¹ Paris letter, Jour Am Med Assn, June 16, 1934, 102, 2035

tarians, Lions, and Kiwanis Clubs, students from Lewis Institute, Armour Institute, and Chicago Technical School

Radiology lends itself so admirably to publicity that when opportunity affords, it should be accepted. It is hoped to arrange similar events in the succeeding years

RESOLUTIONS¹

The following Resolutions were introduced before the American Medical Association, at the Cleveland Session, in June, 1934. Dr. Soiland and Dr. Fisher may be sure that a great body of radiologists share their views

RESOLUTIONS ON EXPLOITATION OF ROENTGENOLOGISTS IN HOSPITALS

Albert Soiland, M.D., of Los Angeles, presented the following resolutions

WHEREAS, It has been reported to the officers and members of the Section on Radiology of the American Medical Association that an intolerable condition exists between certain otherwise acceptable hospitals and their departments of radiology, and

WHEREAS, It is known that in several such hospitals the business management does the collective bargaining for x-ray business with staff members and outsiders to the detriment and professional and financial loss of their staff roentgenologists, and

WHEREAS, Such practice is not only unethical but places such hospitals on a direct competitive medical practice basis with their respective roentgenologists, which practice has been declared illegal in several States, and

WHEREAS, The practice of roentgenology or radiology is *ipso facto* the practice of medicine and cannot be separated therefrom, be it therefore

Resolved, That the House of Delegates of the American Medical Association go on record as opposing the exploitation of members of their own body in the manner outlined, and be it further

Resolved, That the House of Delegates of the American Medical Association in session duly assembled orders this resolution to be referred to the Council on Medical Education and Hospitals for the study and formulation of plans tending to the abatement of these highly unprofessional and obnoxious evils

RESOLUTION AUTHORIZING SECTION ON RADIOLOGY TO INVITE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY TO BE HELD IN AMERICA

WHEREAS, The International Congress of Radiology, which convenes every three years, has already had three such meetings abroad in London in 1925, in Stockholm in 1928, in Paris in 1931 and now in Zurich in 1934, and

WHEREAS, The radiologists of the United States desire to invite the European radiologists to America for the 1937 International Congress, and

WHEREAS, In the opinion of members of the Section on Radiology of the American Medical Association, such an international meeting would at this time engender a national good feeling and would be of high value to scientific radiology, be it therefore

Resolved, That the House of Delegates of the American Medical Association authorize the Section on Radiology to cordially invite the fifth International Congress to be held in America at such time and place as may be decided on by the International Committee of the Fifth Congress of Radiology

RESOLUTIONS BARRING FROM THE PRACTICE OF RADIOLOGY ALL PERSONS NOT LICENSED TO PRACTISE MEDICINE

George M. Fisher, M.D., of New York State, presented the following Resolutions

WHEREAS, The making of a diagnosis by means of the x-rays and for the administration of x-rays, or other radiant energy for treatment, are methods of diagnostic or therapeutic medical practice, and

WHEREAS, The medical practice act makes the diagnosing and/or treatment of disease unlawful for any one not duly licensed to practise medicine, and

WHEREAS, During the past ten years or more lay persons and lay organizations have established and are conducting x-ray laboratories in which lay persons are examining and/or treating patients by means of x-rays, and

WHEREAS, Such lay persons are not properly qualified and are not subject to effective supervision or control, and

WHEREAS, The x-rays in the hands of inexperienced and/or irresponsible persons are in themselves a potential source of injury to the patient, and

WHEREAS, In addition to these dangers, x-ray diagnosis frequently requires the administration of potent drugs or chemicals which may be legally administered only by licensed physicians, and

WHEREAS, Under these conditions the lay

¹ Reprinted by permission of Journal of the American Medical Association June 23 1934 102

the applicants, who have been thoroughly investigated, particularly as to their moral character. For this reason the radiological profession should lend every possible encouragement and co-operation to this Society, and one of the important things it can do is to encourage its technicians to qualify before the Society's Board

MEMORIAL TO
PROF ALBERS-SCHONBERG

The fiftieth volume of the well-known journal named "Strahlentherapie," published in Berlin by Urban & Schwarzenberg, has been dedicated to the late Professor Albers-Schönberg, who died from roentgen injuries. Professor Albers-Schönberg, whose home was in Hamburg, was a pioneer German radiologist and the occupant of the first chair established for radiology in a German medical school

RADIOLOGICAL SECTION OF THE
MEDICAL SOCIETY OF NEW
JERSEY

At the 168th Annual Meeting of the Medical Society of New Jersey June 6 and 7, the Radiological Section presented the following program

Suppurative Hip in Children, G Herbert Taylor, M D, East Orange
Discussant Harold Smith, M D, Orange

Protracted External Radiation in the Treatment of Neoplasms of the Upper Respiratory Tract, Milton Friedman, M D, Newark
Discussant Elwood Downes, M D, Woodbury

Report of a Case of Foreign Body in the Esophagus, Erwin Reissman, M D, Newark

Lung Changes Subsequent to Irradiation in Breast Cancer, Elwood Downes, M D, Woodbury

Intrathoracic Anatomy from the Roentgenologist's Standpoint, William Wallace Maver, M D, Jersey City

Why Gastric Cancers Show Characteristic Roentgen Findings, Lewis G Cole, M D, New York City

Osteogenic Tumors, John Tidaback, M D, Summit, and A F Galasso, M D, Morristown
Discussant F H Pinckney M D, Morristown

The Problem of Silicosis—A Practical Viewpoint, Raphael Pomeranz, M D, Newark

Roentgen Diagnosis of Lesions of the Esophagus, Charles F Baker, M D, Newark, and W James Marquis, M D, Newark

Report of a Case of Mediterranean or Sickle-cell Anemia, Austin Vogel, M D, Elizabeth

The Recognition of Some Forms of Intracranial Pathology, Charles W Schwartz, M D, New York City

Elwood Downes, M D, of Woodbury, was elected Chairman for the coming year

practice to permit untrained medical persons to use such dangerous agencies as the x-ray and radium in the diagnosis and treatment of disease, and how much more dangerous to permit by law non-medical persons the use of these agencies. There are a few laymen who, through years of experience, have developed a mechanical diagnostic instinct, not based, however, on scientific facts or knowledge of roentgen pathology, which is indispensable to accurate diagnosis and effective therapy. A non-medical technician trained in a pathologic laboratory cannot and does not assume the rôle of a pathologist, even though he has learned to recognize the microscopic appearance of certain abnormal tissues. To permit such individuals to diagnose and treat diseases without a medical education would be an acknowledgment that the years of study required to obtain the knowledge to practise medicine are unnecessary.

At the last meeting of the American Medical Association, in the House of Delegates, resolutions were presented which, if carried out, may give us the same results as the recent French law. To demonstrate that we are in need of this reform, we have only to cite the status of radiology in this country a few years ago.

Until recently, 36 per cent of the State Boards of Medical Examiners of this country did not believe the practice of radiology to be the practice of medicine. A great change has occurred since then, but we believe that there are still some who are of the same opinion. The splendid action taken by the American Medical Association, in recognizing radiology on the same basis as the other specialties, has been of great assistance to organized radiology. We are hopeful that the proper officers of this great medical organization will act favorably on the resolutions introduced in the House of Delegates by Dr. Soiland and Dr. Fisher. Such action by the American Medical Association will discourage non-medical men from entering this field, and will also tend to influence proper legislation in those States which have hitherto been reluctant to act.

The excellent co-operation of all the radiological societies in organizing the first American Congress of Radiology has given a splendid boost, these and other factors account for the increased recognition which radiology has received during the last few years. Another important factor which has helped in elevating the standards of radiology is radiological edu-

cation in medical schools. Four years ago, most medical schools in this country did not require a student to take a course in radiology, though most medical schools then offered short courses. Most of these short courses were elective, either under the radiological department or combined with medical clinics. How different it is to-day! A recent statistical study shows that radiology is given a very liberal allowance of hours. We do not mean that it is sufficient or commensurate to its importance, but, when compared with what was given only a few years ago, the increase in radiological teaching hours is most gratifying.

THE AMERICAN SOCIETY OF X-RAY TECHNICIANS

At a recent meeting of the American Society of Radiographers held at Milwaukee, the name of this organization was changed to the American Society of X-ray Technicians. This change in name, we believe, is a good and wise one. The former name would no doubt in certain instances lead to confusion, while the latter name can hardly be misinterpreted.

The members of this Society are to be commended for their attitude toward the radiological profession. When they heard that there was some opposition to the name "radiographer," they immediately sent out a questionnaire to several hundred radiologists for a frank opinion. When the returns were tabulated, it was found that the sentiment of these radiologists was strongly against the usage of the word "radiographer" and favored a change. The change was made by this organization and their action is but another substantial proof of the desire of its members to co-operate with organized radiology.

There is much in common between the radiologist and the x-ray technician, and often the success of the former is to a certain extent the result of good technical work. There can be no denying the fact that a competent x-ray technician is helpful in enabling a radiologist to enlarge his field of endeavor.

The American Society of X-ray Technicians is doing splendid work. The members are qualifying only competent and experienced technicians, and if any one doubts their earnestness in this regard, he has only to see the type of examinations they give. Both oral and practical examinations are used in qualifying

experienced roentgenologists will agree with this

The numerous illustrations (225) are deserving of commendation because of the detail and clarity that have been maintained in spite of the difficulty of reproducing roentgenograms of this type. The topography and arrangement of the text are excellent

X-RAY AND RADIUM INJURIES PREVENTION AND TREATMENT By HECTOR A. COLWELL, M B, Ph D, M R C P, D P H, and SIDNEY RUSS, C B E, D Sc, F Inst P, the Barnato Joel Laboratories, Middlesex Hospital Cloth, pp 212, with two illustrations. Oxford University Press, Humphrey Milford, London, 1934. Price, \$4.75

The importance, in fact the absolute necessity, of a radiologist having a thorough knowledge of the effects of radiation on normal tissues and of the dangers inherent in the use of the physical agents cannot be over-emphasized. With the ever-expanding uses of radium and roentgen rays in the fields of diagnosis and treatment, unfortunately too often it may well happen that patients will be encountered who are suffering from injury sustained long previously or from severe recent improper radiation at the hands of those with but meager experience and training. Also, the radiologist, either from ignorance or carelessness, meanwhile may have sustained irreparable injury to himself. Until the advent of this book there was no text in English which adequately analyzed the effects of radiations on the various tissues of the body, and even though this book is not intended to be an exhaustive treatise on the subject, it will probably be for some time to come the standard reference book concerning it. More important perhaps than the description of the pathologic changes induced in normal tissues by radiations both under clinical and experimental conditions is the inclusion of recommendations for protection against injury. Humphrey Rolleston voices the sentiments not only of the British x-ray and radium protection committee, but of radiologists throughout the world when he remarks in his foreword "We are proud to be allowed to welcome the appearance of such a monumental proof of the need for precautions."

In this reviewer's opinion the book should be owned and read repeatedly by all radiologists and all students of radiology

ROENTGENOSTEREOSCOPY (Das Röntgenraumbild) DR WERNER TESCHENDORF, Chief Physician of the Radiologic Institute for General Ortskrankenkasse, Köln, and Privatdozent at the University of Erlangen, and DR HANS KÖHNLE, roentgenologist of the Internal Medicine Clinic of the Medical Academy, Düsseldorf. A volume of 173 pages and 126 illustrations. Published by Urban and Schwarzenberg, Berlin, Germany, 1933. Price (paper) RM 9, and (bound) RM 10.50

In this monograph the authors discuss the theoretical and technical optical fundamentals of stereoscopic vision as regards its roentgenologic aspects. The structural and stereographic peculiarities of the roentgenostereoscope are discussed in detail, with a consideration of representative types of apparatus. The significant sources of error are indicated and suggestions given as to how to utilize the method to its greatest advantage.

There is an extensive bibliography. Because of the comprehensive and practical manner in which the subject is presented, this book should be of interest to all roentgenologists and others who are interested in the everyday use of this important procedure.

This monograph also appears under the title "Die Röntgenstereoskopie" in Abderhalden, *Handbuch der biologischen Arbeitsmethoden*, Abt. II Teil 3 (Lfg. 408).

FOREIGN BODY IN AIR AND FOOD PASSAGES By CHEVALIER JACKSON, M D, Sc D, LL D, F A C S, Professor of Bronchology and Esophagology, Temple University, and CHEVALIER L. JACKSON, M D, M Sc (Med) F A C S, Professor of Clinical Bronchoscopy, Temple University, Philadelphia. Volume 16, *Annals of Roentgenology*. Edited by James T. Case, M D, Professor of Roentgenology, Northwestern University Medical School, Chicago. A volume of 265 pages, with 236 roentgen-ray studies and 10 clinical illustrations. Published by Paul B. Hoeber, New York, 1934. Price, \$12.00

In keeping with a style frequently used by the senior author the "message" in this monograph is portrayed by axioms and illustrations, most of the latter being roentgenograms. It is emphasized that foreign bodies, if undiscovered, sooner or later prove fatal, whereas if the diagnosis is promptly made the foreign body can be removed by endoscopy through the

BOOK REVIEWS

PRACTICAL X-RAY THERAPY By HUGH DAVIES, M A (Oxon), M R C S (Eng), D M R E (Camb), officer in charge of x-ray therapy, King's College Hospital, Honorary Assistant Radiologist, National Hospital, Queen Square First edition Cloth A volume of 134 pages with 47 illustrations J and A Churchill, London, 1934 Price, 8 shillings and 6 pence

This little book is intended to present the elements of x-ray therapy to the radiologic student and to acquaint the general medical student with the importance of x-ray therapy, a subject which is ever expanding into the fields of medicine and surgery. The presentation is essentially practical and not technical and covers the subject in a fluent, lucid, and, in fact, rather entertaining way. The indications for x-ray therapy, the technique of treatment, and the results to be obtained are outlined in a sound and conservative manner so that a firm foundation is laid for the reader to carry out effective x-ray treatment. The reviewer knows of no easier introduction to radiotherapy than that presented by the author.

MODERN FINSSEN TREATMENT DR SVEND LOMHOLT, Director of the skin clinic of Finsen Institute, Copenhagen A volume of 64 pages and 52 illustrations Published by Urban & Schwarzenberg, Berlin, 1934 Price not stated

This is a reprint of an article which appeared originally in "Strahlentherapie," 1934, 49, 1, concerning the indications for and the results to be expected from Finsen light therapy. One observation of significant interest to the radiologist is that late x-ray reactions, *i.e.*, atrophy, telangiectasis, ulcers, are often benefited by proper Finsen treatment.

NASAL ACCESSORY SINUSES FREDERICK M LAW, M D, Roentgenologist, Manhattan Eye, Ear and Throat Hospital, New York. Volume 15 of *Annals of Roentgenology*, edited by James T Case, Professor of Roentgenology, Northwestern University

Medical School, Chicago. The volume contains 197 roentgenologic (215 pages) studies, 28 clinical illustrations, and 3 key plates. Published by Paul B Hoeber, Inc, New York, 1934 Price, \$10

This is a practical treatise concerning the roentgenologic diagnosis of accessory sinus disease that will be welcomed by all concerned with the subject. The author has approached the matter from the standpoint of both the roentgenologist and rhinologist, and the text reflects his large experience in each field. For the roentgenologist, there is emphasized the character of information to be gained from roentgenograms that would be of help to the surgeon in the event of operative procedure. For the rhinologist, the extreme value to be obtained from a comprehensive knowledge of the anatomy revealed, especially on stereoscopic films, is stressed.

There is an excellent description of the various technical procedures, and all the usual positions for examination are well illustrated. For routine examination the author derives the greatest information from the use of the Caldwell (nose-forehead) and stereoscopic lateral positions. Other positions are taken as indicated. It is to be noted that Dr Law prefers to use a vertical or inclined vertical x-ray beam, instead of a horizontal one which frequently depicts the level of fluid and pathologic changes that might be obscured by it. In his opinion, the presence or absence of fluid is readily ascertained by clinical means.

The chapters on diagnosis and interpretation are excellent expositions of the information that may be gained from an intelligent study of good roentgenograms of the sinuses. The significant point is that in most instances this information may be obtained by the application of the simple and practical technique described by Dr Law, without the use of elaborate or expensive apparatus. Concerning the use of opaque materials injected into the sinuses, the author states that "for surgeons who do not want to inspect films carefully or who want to demonstrate a chronic cavity on lantern slides, the injection method is very satisfactory, but otherwise a diagnosis can usually be made without this method." Most

IN MEMORIAM

CARLOS HEUSER

Dr Carlos Heuser, an international figure in radiology, died in Buenos Aires on March 28, 1934, at the age of fifty-six. He was born in Buenos Aires and pursued his primary and secondary studies in that city. He graduated from the medical school in 1902, his thesis having been awarded the gold medal. From that early date he dedicated himself to the study of radiology. He contributed many improvements to its technic and wrote many articles—published, for the most part, first in the "Prensa Medica Argentina," as well as several books on radiology. Among these were a practical treatise on radiology and superficial and deep radiotherapy for which he received the prize of the faculty of medicine of Buenos Aires. He also wrote a book on the use of the x-ray in gynecology, obstetrics, and urology, numerous articles on arteriography, hepatohenography, amniography, intravenous pyelography, and many articles on hydatid cysts both from the standpoint of diagnosis and treatment, also on the diagnosis of pregnancy in the early months by means of the x-ray, etc. Dr Heuser took part in numerous international congresses, and in 1930 received the gold medal of the Radiological Society of North America. He was a corresponding member of the American Roentgen Ray Society, and an honorary member of the American



The Late Carlos Heuser, M D

College of Radiology. Apparently, Dr Heuser was the first to use lipiodol for uterosalpingography, having accomplished this in 1921. A full report of this work was made in 1924 for Dr Heuser by the writer, at the Latin-American Scientific Congress, in Lima.

JAMES T. CASE, M D

mouth and the patient cured in 98 per cent of the cases. With this in mind the subject has been treated from the viewpoint of how the roentgenologist can be of the utmost help to the endoscopist. It has been assumed that the reader has a fundamental knowledge of the science of roentgenology and roentgenologic anatomy. The valuable information and suggestions that are embodied in the axioms and legends of the numerous illustrations reflect the meticulous care that must be used in studying cases of this sort and which is so necessary to a successful consummation of the problem at

hand. It is to be regretted that greater credit has not been given to the authors' roentgenologic colleagues who have done much to develop the roentgenologic foundations upon which modern oral endoscopy is so dependent.

The scope of this book and its value to the roentgenologist might have been considerably increased if a section concerning the subject from the standpoint of a roentgenologist had been added. Nevertheless, experienced roentgenologists will appreciate the lessons unfolded by this work and the novice will profit much by it.

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ABSCESSES

Treatment of Acute Pulmonary Abscess S U Marietta Jour Am Med Assn, April 28 1934, 102, 1363-1368

This discussion has to do with single (including multilocular) abscesses and does not include those due to tuberculosis, bronchiectasis, and new growths. The treatment of all acute cases is medical until it becomes evident that such treatment will not succeed. The period of medical treatment varies from six to twelve weeks. Physical examination and roentgenograms are of great assistance in decision for surgery, collapsibility increases with the distance of the lesion from the pleura. When the visceral and parietal layers of pleura become adherent, elimination of the cavity by contraction becomes difficult. The etiologic factors have directly to do at times with the form of treatment to be undertaken. Aspiration from a foul mouth may be a cause—early treatment with arsenical preparations has controlled this type. Commonly streptococci (rarely pneumococci) bronchopneumonia, aspiration of a foreign body or septic material and septic emboli are the factors. Over half the cases respond to conservative measures. The elimination of a chronic lung abscess by medical treatment alone is not to be expected.

C G SUTHERLAND, M D

APPARATUS

Electrical Phenomena in High Tension Circuits of Roentgen Apparatus G Grossmann Fortschr a d Geb der Röntgenstrahlen 1933 48, 450-474 1934, 49, 1-31

The introduction describes the capacitative relationship of the high tension system of a roentgen installation to its grounded parts. In ungrounded apparatus this refers particularly to the capacities existing between the secondary windings of high tension and filament transformers and their low tension sides. In shock proof installation one has to consider in addition the high capacities of the cables.

Capacities of half wave apparatus are distributed asymmetrically consequently their potentials also are

distributed asymmetrically. The influences of capacities and conditions of insulation upon height and phase of potentials existing between the terminals of a transformer and ground are demonstrated mathematically. Furthermore, the influence of the capacity of the side of a transformer, separated from ground by a half-wave rectifying kenetron tube, upon the potential of this terminal to ground is demonstrated. This capacity, comprising in a shock-proof installation with half wave kenetron rectification one filament transformer and one cable ('terminal capacities'), is changed during the working phase, during which period damped medium and high frequency oscillation develop, and then discharged through the roentgen tube.

Diagrams illustrate the fluctuations of potentials at the roentgen and kenetron tubes under varying conditions of output. Influences of the capacities mentioned upon phenomena in the primary transformer-circuit are discussed and the currents passing through a person touching one high tension terminal are calculated.

In the second part of this paper the voltage curves of fully valve rectified and also of condenser-equipped apparatus are introduced. Only in the Liebenow circuit can one regard terminal capacities as a desirable addition to the energy-storage for activation of the roentgen tube. They are decidedly disadvantageous in non-shock proof apparatus with kenetron half-wave rectification in the Villard type machines, and those with triplication of potentials they are of no consequence in full wave rectification. Cables of shock-proof apparatus have to withstand electrical stresses in proportion to amplitude and frequency of potentials applied.

The paper is profusely illustrated and will be of great interest to all those familiar with detail of construction of roentgen apparatus and the problems of the various circuits and of shock proofing.

H A JARRE, M D

ARTHRITIS

The Relation of Trauma to Arthritis Howard P Doub Am Jour Roentgenol and Rad Ther, July, 1933 30, 26-33

ABSTRACTS OF CURRENT LITERATURE

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ERNST A POHLE, M D, Ph.D of Madison, Wisconsin
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neurotrophic disturbances Infection and trauma are considered the most important of these factors

Pathologically, the first signs to be noted consist of a low grade chronic inflammation as shown by thickening and edema of the periosteum, proliferation of fibroblasts, and round-cell infiltration Subsequently, lime deposits occur beneath and outside the periosteum in the regions of the insertions of the tendon and fascia In the advanced cases, microscopic examination of sections of bone shows fibrosis of the marrow tissues, small areas of necrosis, hyaline degeneration proliferation of fibroblasts, and sclerosis of the cortical bone

Pain and tenderness over the affected area are considered the symptoms of most importance The pain which may be dull or sharp, constant or intermittent, is first noted only during walking The small, sharply defined spur usually causes piercing pain, while the more extensive periostitis results in dull, aching pain Swelling over the inflamed area is seen in the more advanced cases

The diagnosis of this condition depends upon the roentgen ray examination which also determines accurately the area of involvement and stage of development This method of examination likewise offers the only means of differentiating periostitis of the os calcis from arthritis, arch strain, osteoma, and lesions of the medullary portion of the bone While this condition usually occurs in adult life in rare cases it is noted during adolescence and then it should not be confused with apophysitis which is an involvement of the posterior inferior epiphysis In the latter disease, roentgenograms show irregularity, clouding and obliteration of the cartilage plate of the epiphysis

The treatment of periostitis of the os calcis may be non-operative or operative The authors are of the opinion that every case should be first treated conservatively The non-operative form of therapy consists of attempts to eliminate the etiologic factors and the institution of rest and local applications to relieve the pain The operative treatment consists of the removal of spurs and the denudation of the roughened areas of periostitis

J N ANÉ, M D

Tuberculosis of the Shaft of Long Bones Report of Six Cases George W Vangorder *Jour Bone and Joint Surg*, April, 1934, 16, 269-283

The author reports a series of six cases of tuberculosis of the shaft of the long bones and discusses the clinical pathologic, and roentgenologic characteristics and the treatment of this condition

With rare exceptions tuberculosis of the shaft of the long bones occurs in the earlier years of life, as shown in the author's series, in which the ages of the patients ranged from nine to twenty-one years The clinical features of the disease are manifested by (1) local thickening of the affected bone, (2) pain, (3) muscular wasting, (4) abscess formation, (5) sinus formation in the late stages The appearance of the affected bone in this condition is not characteristic and may simulate any thickening of bone such as is found in

pyogenic osteomyelitis, syphilis, or neoplasm As a rule, however, the enlarged shaft is not noticeably tender to pressure and there is no increased local temperature or redness until the formation of soft part abscesses Pain is an exceedingly variable symptom It may be marked, slight, or absent This has been explained as due to the variation in interosseous tension, which is found in the various stages of the disease Muscular wasting is not as common in tuberculosis of the shafts of the long bones as in tuberculosis of the joints Abscess formation as a result of local softening and caseation within the bone is a characteristic feature Sinus formation is seen only in the late stages of the disease when the bone abscess has extended into the soft parts and worked its way to the surface of the skin As a rule, there is no fever and no leukocytosis, and the general health is not greatly disturbed

Any portion of the shaft of a bone may be involved by the tuberculous process and the characteristic pathologic feature is the formation of an abscess This abscess formation results in a definite reaction by the surrounding bone structures, which is more marked in the diaphysis than in the metaphysis The subsequent course of the bone abscess may be (1) to remain encysted (2) to spread along the marrow cavity, (3) to extend from medulla to periphery and invade surrounding soft parts, (4) to extend from metaphyseal focus into the epiphysis and then into a joint

Roentgenologically the characteristic features of tuberculosis of the shaft of long bones are the central origin of the focus, the abscess formation, and the lack of sequestrum formation The reaction of the surrounding osseous tissue to the abscess varies in different portions of the shaft In the metaphyseal portion of the bone, little or no reaction is noted either in the periosteum or in the region of the adjacent bone lamellæ However, in the diaphyseal region the periosteal and lamellar reaction about the tuberculous focus is very marked Of interest is the fact that while no apparent expansion of the shaft is noted in the metaphysis, when the focus is located in the diaphysis one of the outstanding features is the local expansion of the shaft This characteristic local expansion of the bone helps to differentiate the lesion from Brodie's abscess and from simple bone cyst, while giant-cell tumor may be ruled out on the basis of its rare occurrence in the mid portion of long bones

The treatment employed in these cases consisted of subperiosteal excision of the bone abscesses, which resulted in complete cure in all of the cases except one, in which no end result was obtained

J N ANÉ, M D

Osteochondritis Focal and Multiple Maxwell Harbin *Am Jour Roentgenol and Rad Ther*, June, 1933 29, 763-765

The true etiology of this condition remains unsolved, due in large measure to the lack of pathologic material from which to draw conclusions While many cases

Injury of sufficient severity to produce damage to cartilage is often followed by chronic tissue changes called "traumatic arthritis," although the writer would prefer the term "chronic traumatic joint reactions." There is considerable difference of opinion as to the exact mechanism which enters into the development of joint changes in chronic hypertrophic arthritis. Some believe the underlying pathology is in the nature of a localized arteriosclerosis producing a state of ischemia, but others believe the condition one of hyperemia persisting for ten days or longer following trauma. Axhausen concludes that cartilage necrosis with the presence of devitalized cartilage in the joint is the cause of arthritis. Fisher on the other hand attributes the changes of osteo-arthritis to prolonged or often repeated injury either mechanical or toxic, but of moderate intensity. In cases in which trauma is often repeated it may be the direct etiological factor, but if there has been only a single contusion, it is apt to be only a predisposing cause.

The earliest joint changes demonstrable in a joint following trauma were those in a knee six weeks after injury to a proven normal part, however the average interval is three to six months and it may take years.

Hypertrophic arthritis tends to be generalized, while traumatic arthritis is usually limited to one joint. However, the x-ray appearance of hypertrophic arthritis and traumatic arthritis may be quite similar in any given joint, hence the history and physical findings are necessary for differentiation.

In a clinic referred to by the author in a series of 124,000 cases with the same type of injury, a relation between trauma and hypertrophic arthritis was established in only eighteen.

Criteria for establishing a diagnosis of traumatic arthritis should include the following: (1) proof of sufficiently severe injury to damage joint cartilage; (2) injury must have been directly to the joint in question; (3) knowledge of previous function of joint must be available; (4) the time interval between injury and development of joint changes must be within accepted limits; and (5) there must be clinical and roentgenological evidence of pathologic tissue changes.

J E HABBE, M.D.

BONES (DISUSE)

The Effects of Immobilization on Normal Bone. Francis M. Conway and John G. Stubenbord. *Jour Bone and Joint Surg.* April 1934, 16, 293-302.

The authors studied the effects of immobilization on normal healthy uninjured bone by means of the roentgen ray to determine whether immobilization alone was responsible for the atrophy and osteoporosis seen on the x-ray film of fractured bones which had been immobilized for a period of from ten to fourteen days. Wolff's law states: "All changes in the function of a bone are attended by definite alteration in the internal structure." As a result one would expect atrophy of a part through disuse.

It has been generally noted that, following injury to a bone, osteoporosis results in the bone. This is caused by the decalcification or the absorption of the lime salts. While the cause of decalcification is not thoroughly understood, it is believed to be due to a change in the metabolism of the bone resulting from the injury, because of interference with the circulation. The usual roentgen signs of these changes in bone consist of: (1) decrease in the density of the bone, (2) thinning of the cortex, (3) apparent widening of the medullary canal.

In this study the authors selected only normal healthy individuals—patients who were forced to remain in the hospital because of accidental injury and those who had some definite complaint of short duration but whose general health was excellent. Cases of asthma, bone diseases, chronic constitutional diseases, diseases in which there were circulatory disturbances, chronic hyperthyroidism, parathyroid disease, and pregnancy were considered unsuitable for this study and were not so employed. No effort was made to regulate the diet of these patients in any manner. There were no blood-calcium content investigations included in this study. All roentgenograms were made by the same technician on the same machine with all technical factors constant.

The wrist and forearm were selected as the most suitable bones for this study, with the exception of one case in which the knee was immobilized. Roentgenograms were made of both wrists and forearms in anterior, posterior, and lateral positions at the beginning of the study. Then one wrist and forearm was immobilized by means of anterior and posterior plaster of-Paris splints held by a bandage. The length of immobilization varied from seven to twenty-four days. At the end of the period of immobilization roentgenograms were again made of both wrists and forearms in the same positions previously employed. In no case were any bone changes noted as a result of immobilization. The authors therefore, concluded that in the absence of injury there are no signs of atrophy in normal healthy bones through disuse *per se* during a period ranging up to three weeks so far as may be observed from the roentgenograms.

J N ANÉ, M.D.

BONE DISEASES (DIAGNOSIS)

Periostitis of the Os Calcis. C. C. Chang and Leo J. Miltner. *Jour Bone and Joint Surg.* April 1934, 16, 355-364.

The authors discuss the etiology, pathology, diagnosis, and treatment of periostitis of the os calcis. This condition is characterized by a deposition of lime or a proliferation of bone on the surface of the os calcis, chiefly near the sites of origin of the plantar fascia and the insertion of the Achilles tendon.

The etiological factors described are as follows: (1) gonorrhea, (2) trauma, (3) arthritis, (4) streptococcal foci of infection, (5) metabolic disturbances, (6) syphilis, (7) arteriosclerosis, tuberculosis, and (8)

iodide The auricle is reached by means of a roentgen-opaque probe, which is introduced into one of the cubital veins, its gradual advance being followed radioscopically, on the screen The probe has been sterilized beforehand, and kept in a sterile (10 per cent) solution of sodium citrate Simultaneously with its introduction small quantities of physiologic serum are injected by means of a syringe fitted to its other end in order to make the progress easier and prevent the formation of any blood-clot within the tube

When the probe has been introduced, the roentgen apparatus is made ready for the taking of the roentgenograms, and the cassette is placed against the anterior side of the patient's thorax The syringe used for the physiologic serum is now exchanged for another, containing the sodium iodide solution The patient is told to take a deep inhalation after which he must remain absolutely motionless The opaque solution is then injected as rapidly as possible the injection being stopped as soon as from 6 to 8 cm has been introduced The syringe is then once more exchanged for the one that contained the physiologic serum, in order to withdraw from the probe the sodium iodide solution that might remain in the latter and finally also the probe itself is gently withdrawn

The patients subjected to this angiopneumographic examination do not experience any discomfort worthy of note from the operation At most, there may be a brief spell of coughing when the injection is finished and sometimes a slight headache, which however, soon disappears To prove the value of the visualization of the pulmonary vessels it suffices to compare, in each individual case the plain roentgenograms with the corresponding angiopneumograms The study of the two seems to evidence the scientific importance of this new process as a means of roentgenographic interpretation in cases of pulmonary lesions

J E HABBE M D

THE EYE

Apparatus for Reading with Closed Eyes A H Pirie *British Jour Radiol*, February, 1934, 7, 111-116 Reprinted by permission from *British Med Jour*, May 26 1934 page 83 of the *Epitome of Current Medical Literature*

The author describes an apparatus which enables the patient to see with closed eyes by the use of x-rays A complete x ray outfit apparatus is used with an eyepiece, behind which is a transparent wheel having on it mounted lead letters forming words These can be read through closed lids since the x rays are perceptible by the retina Among the possible uses listed by the author are the following A patient with a foreign body in his eye can see it locating it in two dimensions and with moderate accuracy in the third Damage to the retina caused by a foreign body can be located by the patient He can also distinguish between these two contingencies and it is suggested that he might be able to detect a foreign body lying behind the eye, the rays being passed through the

skull to the retina from behind The condition of the retina can be ascertained in a case of complete cataract The field of vision can be mapped out by the patient, and minute scotomas localized at once A foreign body lying laterally to the retina can be made to cast its shadow on the near side and on the far side of the retina, and the patient can thus be enabled to see two shadows—proving that the foreign body is outside the globe The patient cannot recognize his own blind spot, as it is lost in the brilliant field of light which is seen

Pirie states that an examination lasting two minutes is quite safe, and well below epilation dose A time switch which runs for ten seconds, reminds the examiner of the quantity of rays entering the eye In order to locate a foreign body or scotoma, or to map out the field of vision, a lead diagram, consisting of a cross with a perpendicular and a horizontal arm, is placed in front of the eye Thus casts its shadow on the retina dividing it into four quarters The patient describes what he sees in each quarter If a foreign body is present, casting its shadow into the upper and outer quadrant the observer reports it in the inner and nasal quadrant Finer subdivision for localization is obtainable by using a star with eight arms and by having a lead circle, or even two concentric lead circles, to measure the distance from the center of the retina The depth of a foreign body from the front of the cornea can be roughly estimated by its change of apparent position when oblique rays are cast on the retina It is suggested also that glass fragments might be localized by the fluorescence they set up in x-rays

FOREIGN BODIES

Foreign Bodies in the Urinary Bladder W P Garshwiler, A F Weyerbacher, and James F Blach *Am Jour Surg*, November 1933 22, 199-202

Five cases of foreign body in the urinary bladder are herein reported three of which were introduced to produce sexual excitement one to produce abortion and one following a surgical injury to the bladder Three of the foreign bodies were removed cystoscopically, one by suprapubic cystostomy and one by external urethrotomy

DAVIS H PARDOLL, M D

FRACTURES

Inadequate Immobilization and Non union of Fractures R Watson Jones *British Med Jour*, May 26, 1934, No 3829 936-939

While the old form of treatment of fractures consisted of excessive immobilization of joints which too frequently resulted in crippling disabilities, there has been noted a modern trend of undue enthusiasm in the mobilization of joints which results in the improper immobilization of the fracture The essential principle of modern treatment is complete immobilization of the fracture with, at the same time, active movement of every joint which need not be immobilized The

show involvement of only one growth center, other cases show multiple involvement, and the condition has been found to be present in several members of one family hence the author considers it probable that more than one etiologic agent may be a factor. The theory of trauma with disturbance of blood supply has seemed likely in many instances but it is not consistent with the histologic picture of increased vascularity seen in most cases. Similarly the infection theory is not supported by positive cultural findings in many cases. During the period before this condition was established as a disease entity many patients were considered to have tuberculous joint disease fortunately, because of the differential aid offered by the roentgen ray, such mistaken diagnosis is rarely made now.

J E HABBE, M D

CANCER (DIAGNOSIS)

Cancer, with Special Reference to Early Diagnosis
Roy Ward British Med Jour, May 19, 1934 No 3828 881-884

The author analyzes the statistics of the mortality rate of cancer in the British Empire and discusses the importance of early diagnosis and proper treatment with suggestions for a policy of public education.

In the year 1912, 37,323 persons died from cancer of all types in 1922 this increased to 46,903 deaths and in 1932, 60,716 deaths occurred as a result of cancer. While it may be argued that this increase during the twenty-year period resulted from better methods of diagnosis which revealed more cases of internal cancer, the statistics for breast carcinoma which is quite obvious in the later stages, would indicate an actual increase in the number of cancer deaths. The statistics for deaths from cancer of the breast only are as follows: 1912, 3,756; 1922, 4,868; and 1932, 6,435.

The estimation of the present methods of treatment of cancer is extremely difficult because of the impossibility of obtaining comparable statistics on a reasonably large scale. It is believed that while surgery has about reached the pinnacle of accomplishment, it will always be the method of choice in certain types of cancer. In the case of radium and x-rays experience during the last thirty years would indicate that much more will be done with these two agencies and that progress is slowly but surely being made. It is considered of the greatest importance that surgery and radiation should not be divorced. In order that the greatest benefit may be obtained from all three methods of treatment the author suggests the following: (1) decision of its own cancer policy by the members of the staff of every hospital treating cancer, (2) a system for tracing the subsequent history of every case of cancer treated to determine the value of the method or methods employed, (3) uniform records of cancer cases, (4) comparable statistics and (5) co-operation between institutions and centers treating cancer.

The significance of the early diagnosis and treatment of cancer should be made known to the general public in somewhat less dramatic form than widespread dissemination of warnings, which will only encourage cancerphobia. It is suggested that the health column of the daily press be employed for the purpose of educating the public as a whole in regard to the cancer problem. Another method of serving the public interests would consist of free periodic examinations.

The author suggests the establishment throughout the country of a number of centers devoted to deep x-ray and radium beam treatment. Each center would have a definite policy which should be known to the other centers in order to prevent overlapping. The function of the medical men outside of the centers would be to supply the various units with the type of case required, and later to assist in following up the patients.

J N ANÉ, M D

CANCER (THERAPY)

The Significance of a General Disposition of the Organism for the Development of Cancer and the Possibilities of its Treatment B Fischer-Wasels Strahlen therapie, 1934 50, 5-78

This article presents a critical review of the literature dealing with the relation between disposition to cancer and cancer therapy. The author and his associates have done considerable experimental work along these lines and the essay is well worth study in the original. He states in the conclusion that his efforts will well be compensated if his clinical colleagues recognize more the importance of the systemic phase of cancer therapy. A most complete bibliography is appended.

ERNST A POHLE M D Ph D

Studies Concerning the Influence of Therapeutic Radium and Roentgen Irradiation on Blood Cholesterol and on the Liver Kurt Fuge Strahlentherapie 1934 50, 157-166

The blood of 31 women with cancer was studied before and after radium and roentgen therapy. It appeared that the blood cholesterol was not increased as compared with normal controls. In some cases there was a decrease and in some an increase of the cholesterol immediately after irradiation. No evidence of an injury of the parenchyma of the liver could be detected with the methods used by the author.

ERNST A POHLE M D Ph D

CONTRAST MEDIA

Visibility of Pulmonary Vessels (Angiopneumography) Lopo de Carvalho and Egas Moniz Acta Radiol 1933 14, 433-451

After numerous experiments on rabbits, dogs and monkeys the authors have succeeded in visualizing the pulmonary vessels in man. The process consists in the injection into the right auricle of the heart of a highly concentrated (120 per cent) solution of sodium

iodide The auricle is reached by means of a roentgen-opaque probe which is introduced into one of the cubital veins, its gradual advance being followed, radioscopically, on the screen The probe has been sterilized beforehand, and kept in a sterile (10 per cent) solution of sodium citrate. Simultaneously with its introduction small quantities of physiologic serum are injected by means of a syringe fitted to its other end in order to make the progress easier and prevent the formation of any blood-clot within the tube

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DAVIS H PARDOLL, M D

FRACTURES

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While the old form of treatment of fractures consisted of excessive immobilization of joints which too frequently resulted in crippling disabilities, there has been noted a modern trend of undue enthusiasm in the mobilization of joints which results in the improper immobilization of the fracture The essential principle of modern treatment is complete immobilization of the fracture with, at the same time, active movement of every joint which need not be immobilized The

author believes that the many theories of inadequate blood supply, impaired nutrition, inaccurate apposition of fragments, failure of impaction, the inhibitory action of synovial fluid, and the absence of blood clot are of no real significance. The only important cause of non-union is inadequate immobilization

It was formerly erroneously believed that decalcification of infected bone resulted from an increased blood supply, while the decalcification of fractured bone was due to an impairment of the blood supply. It has been proved that hyperemia of bone always results in decalcification, regardless of the cause of the increased blood supply. Increased calcification, or sclerosis, on the other hand, is the result of impairment of blood supply, as may be seen in Charcot's disease

In fractured bone the initial traumatic hyperemia gives rise to decalcification of the bone ends. When this hyperemia subsides calcium salts are deposited in the young connective tissue which has grown between the bone ends to form callus. When, in the final stages, the blood supply becomes impaired, the callus undergoes dense calcification, with consolidation of the union. Improper immobilization results in the tearing of the young connective tissue between the fragments. These repeated injuries to the fractured region result in constantly recurring hyperemia, with increased decalcification of the bone ends. When the stage of repair and fibrosis is reached there will be no connecting bridge of callus to recalcify, and non-union will result. Even with proper immobilization for several weeks, if the fractured bones are then strained before consolidation has occurred, traumatic hyperemia results immediately. Recalcification ceases at once decalcification supervenes, and non union develops

With these fundamental principles regarding the healing of fractures in mind it is urged that complete and adequate immobilization be continued until the roentgenogram reveals evidence of consolidation. Fractures of the carpal scaphoid should be completely immobilized with an unpadded plaster cast, and while the average duration of immobilization is a little over two months occasionally it is necessary to continue for from six to twelve months. It is believed that the continued rotation movement of the upper fragment in fractures of the femoral neck results in the high percentage of non union which is seen in these fractures. This movement may be prevented by the use of the Smith-Petersen nail, and satisfactory union obtained in from 90 to 100 per cent of these cases. In the treatment of fractures of the lower shafts of both forearm bones immobilization is usually continued for from seven to eight weeks. This results in stiffening of the inferior radio-ulnar joint and with the removal of the splints movement will occur just as easily at the unconsolidated fracture of the ulna as at the inferior radio ulnar joint. This produces repeated torsion strain in the ulnar fracture with resulting traumatic hyperemia and decalcification and non union. In the radius both fragments move

together and there is no rotatory strain and the callus continues to calcify until union is consolidated. The infected compound fracture is pathologically similar to the simple fracture, except that the initial stage of decalcification is prolonged

J N ANÉ, M.D

Fracture of the Ulna, with Dislocation of the Head of the Radius S. R. Cunningham Jour Bone and Joint Surg, April, 1934, 16, 351-354

The author is of the opinion that fracture of the ulna, with dislocation of the head of the radius, is frequently overlooked in the early stages. Since good results are usually obtained in cases recognized and treated early and since unrecognized and neglected cases result in loss of function and deformity, the diagnosis of the complication is very important

It is believed that in all fractures of the upper half of the ulna, with displacement of the fragments the radio-ulnar joint is of necessity involved. This condition may be the result from a fall upon the palm or thenar eminence of the hand, or from a direct blow against the extensor surface of the forearm near the junction of the upper and middle thirds of the ulna. Young workmen and children between the ages of three and twelve years were found to comprise the largest groups suffering from this injury. In the author's series of 257 cases of ulnar fracture, 14 or 5.5 per cent had an associated complete dislocation of the head of the radius

As a result of the upward and forward displacement of the distal fragment of the ulna, the radius is likewise directed upward and forward because of its attachment by the interosseous ligament. This results in the displacement of the head of the radius upward on the anterior surface of the humerus

The injured arm is usually held in partial flexion at the elbow, and there is definite swelling in the upper half of the forearm and upper arm. The upper fragment of the ulna is pulled backward and the lower fragment upward and forward. This displacement tends to fill the normal depression in front of the elbow. The head of the radius can be usually palpated in this region

The author stresses the importance of very careful and thorough roentgen ray examinations, with particular care to include the elbow joints in all ulnar fractures

J N ANÉ M.D

GENITO-URINARY TRACT (DIAGNOSIS)

Physiology and Pathological Physiology of Dynamics of the Urinary Passageways Maurice Muschat Am Jour Surg January 1934 23, 129-132

The author feels that the dynamics of the calices have a great deal to do with stone formation in the kidney. Proper drainage of a calyx is of paramount importance. If for one reason or another the drainage

is impaired stagnation will occur, with the inevitable formation of stones. Such stagnation can be caused through a topographic misplacement of the calyx, obstruction at its outlet, or through lack of muscular expulsive power to drive out the urine.

The physiologic facts, learned in the past decade concerning the dynamics of the urinary passageways, teach that no radical surgery should be done upon these organs before a careful analysis of their true function has been made. Such true facts can best be obtained by intravenous urography. There is less radical renal surgery done every day, fewer nephrectomies are performed because it is realized how little functioning renal tissue is really needed for complete or partial renal recovery after removal of the offending cause.

As can readily be appreciated, there is very little that can be done medically to correct the deranged dynamics of these organs. Procrastination in re-establishing normal pressures within these urinary compartments will always lead to inevitable kidney atrophy and grave morbidity which, in turn, will shorten the span of life.

DAVIS H. PARDOLL, M.D.

The Surgical Management of Bilateral Nephrolithiasis. Francis Patton Twinem. *Am Jour Surg* April 1934, 24, 124-128.

The author states that about 13 per cent of cases of renal stone show bilateral involvement. Bilateral stone is usually preceded by a bilateral infection. A bilateral operation should be done only in easy cases, in young subjects and in cases in which only slight or no infection is present.

Usually the better kidney should be operated on first. Certain exceptions are mentioned.

The surgical indications in various types of bilateral stone are discussed. This type of patient requires the most meticulous care if the best results are to be obtained.

Several illustrative case records are given.

DAVIS H. PARDOLL, M.D.

Calculus Pyonephrosis. A Clinical Study, with Especial Reference to Etiology and Treatment. Review of the Literature. Report of Six Cases. I. E. Nash. *Am Jour Surg*, April 1934, 24, 110-118.

The author briefly reviews the literature on calculus pyonephrosis. He points out that most of the cases occur in young women who marry at an early age and rapidly go through multiple pregnancies. He suggests that there may be a urinary diathesis which predisposes these women to infection and stone formation in the kidneys analogous to those women with a biliary diathesis in whom the disease of the gall bladder is laid down at the time of the first pregnancy.

He considers the treatment of the acute and chronic type of case. For the latter, he suggests that first a nephrotomy be done to be followed by a secondary transperitoneal nephrectomy, because the abdominal

approach enables one to avoid the hemorrhage and other complications incident to a lumbar nephrectomy.

The article is accompanied by several case reports and pyelograms.

DAVIS H. PARDOLL, M.D.

GYNECOLOGY

Radiological Diagnosis in Metrorrhagia. Carlos Heuser. *Semana Méd*, Aug 31, 1933, p 622. (Reprinted by permission from *British Med Jour*, Dec 16, 1933, p 100 of *Epitome of Current Medical Literature*.)

The author reports several cases in which, with hipodol and very simple technic, he succeeded in demonstrating by radiography the differential diagnoses of various metrorrhagias. He found it easy to ascertain the presence of serous and placental polyps, carcinomas of fundus and cervix, and submucous fibromas, as well as to estimate quite accurately the development and progress of cases treated by radium, no matter in what part of the internal genitalia the disease lay. The ten cases he reports are illustrated by unusually clear roentgenograms, and the writer claims that without radiography correct investigation would have failed.

Diagnosis of Uterine Hemorrhages at the Age of the Menopause. J. Quénu and C. Bécclère. *Bull Soc d'obst. et de gynec*, November, 1933, 22, 742-748. Reprinted by permission from *British Med Jour*, June 16, 1934, page 96 of the *Epitome of Current Medical Literature*.

The authors analyze 44 cases of menopausal metrorrhagia. While 27 per cent are due to organic causes, such as carcinoma of the fundus uteri (9 per cent), fibroma, polyp, etc., they regard no less than 73 per cent as functional—of ovarian origin, either hormonal or infective. For this group they suggest the term "benign glandular hyperplasia." For all cases of metrorrhagia at the menopause, they strongly advocate diagnostic curettage. Of the benign cases, two-thirds are cured by curettage without further treatment. The remaining one third start bleeding again after a few months and for these x-ray treatment of the ovaries is recommended to hasten the menopause.

In a subsequent paper C. Bécclère further discusses benign glandular hyperplasia. Analyzing 38 more cases of menopausal metrorrhagia, he attributes 64 per cent to this condition. Microscopically these cases show no inflammatory or neoplastic change in the uterine mucosa having the physiological appearances of premenstruation and nidation. That these are due to a modification of the ovarian hormones is borne out by the fact that if these cases are treated by x-rays to ovaries only, the hemorrhage is arrested, whereas after curettage it often recurs and continues till ovarian function finally ceases at the menopause. The clinical syndrome is (1) abrupt onset of metrorrhagia in patients previously regular in menstruation,

(2) periods of two to three months' complete amenorrhea, (3) irregular alternation of amenorrhea and metrorrhagia. These features, in the author's opinion, further indicate the origin of the bleeding to be ovarian dysfunction, since in cases of *pathologic* changes in the uterine mucosa there is usually some previous menstrual irregularity and no such periods of amenorrhea. Although the syndrome described is characteristic of functional metrorrhagia of ovarian origin, curettage and microscopical examination of the debris is recommended, both to confirm diagnosis and to stop hemorrhage temporarily at least, pending permanent cure by the application of x-rays to the ovaries. In atypical cases hystero-graphy should precede curettage to indicate any area of the uterus particularly suspicious of pathologic change.

THE JOINTS

Calcification in Fat Pads about the Joints. Albert B. Ferguson. *Jour. Bone and Joint Surg.*, April, 1934, 16, 418-422.

The author reports a series of four cases in which roentgenographic examination revealed flaky, calcareous deposits in the form of short rods or dashes in the region of the fat pads about the joints. As duration increased, the particles tended to appear more nodular.

Of the four cases, three gave a history of onset following trauma. In Case 1, the patient was a female, 9 years of age, who showed involvement of the left shoulder joint. Case 2, a boy, aged 16 years, revealed these deposits in the region of the right elbow joint. Case 3, a female, aged 58 years, had calcification in fat pads about the right knee. In Case 4 the patient was a female, 22 years of age, with involvement of the left knee.

Microscopic examination of sections of tissue removed surgically from two of the cases revealed fatty tissue showing masses of rather cellular cartilage, with small areas of ossification scattered through it and traces of fat remaining between the cartilage masses.

J. N. ANÉ, M.D.

THE KNEE

A Case of Tuberculous Infection of the Knee with Clinical and Roentgenographic Appearance of Charcot's Disease. Knut Bennet and Harry Hinricson. *Jour. Bone and Joint Surg.*, April 1934, 16, 463-466.

The patient, a male, aged 40 years, was admitted for hospitalization in September, 1931. At that time he presented a marked gibbus of the middle of the thoracic region, some affection of the left knee and two fistulae near the upper part of the sternum. With the exception of a brother who had had a tuberculous spondylitis, the family history was essentially negative.

Ten years before admission, the patient stated the left knee began to swell and became painful particularly at night. The patient changed his occupation

and the pain disappeared but the lump remained. In 1924 he was treated for tuberculous spondylitis. At this time roentgenograms of the left knee showed a normal joint space, an uneven defect in the lateral corner of the left condyle, roughened joint surfaces, and increase in breadth of the intercondylar fossa.

In 1931 the knee showed enlargement and a spindle shaped form, with a diffusely thickened capsule, but without effusion. Roentgenograms revealed marked destruction, with sharply sclerotic borders in the tibia as well as the femur, and several sequestral shadows of striking density, the size of an almond shell. In spite of the existence of a tuberculous focus elsewhere and the negative cerebrospinal fluid and blood Wassermann reactions, Charcot's arthropathy was considered because of the total absence of pain and the x-ray appearance of the lesion. Anti-syphilitic therapy was instituted, and with a view of producing ankylosis to effect a cure the knee joint was resected. It was then found that the area of destruction disclosed by the roentgenogram was filled with masses containing a number of markedly sclerotic sequestra. At the back of the femur was an abscess containing caseous masses and pus-like material. Patho-anatomical examination revealed chronic inflammation of no specific character. Guinea pig tests proved the presence of tubercle bacilli.

J. N. ANÉ, M.D.

THE LARYNX

Radiation Therapy of Tuberculosis of the Larynx. J. Zange. *Strahlentherapie*, December, 1933, 48, 705-727.

The author discusses his subject at length. The productive type of the disease often responds well to x-ray therapy. Doses of from 30 to 50 per cent E.D. are recommended, and they may be repeated at intervals of from 4 to 8 weeks.

ERNST A. POHLE, M.D., Ph.D.

Malignant Disease of the Larynx and Pharynx. R. Stewart-Harrison. *Strahlentherapie*, 1934, 50, 91-126.

The author describes in detail the use of the protracted fractional dose method (Coutard) in the treatment of tumors in the larynx and pharynx. A number of case histories are given in order to illustrate the variations from the standard technique which are often necessary to suit the needs of the individual patient. In the author's opinion there is a close relationship between histology of the tumor and its radiosensitivity. Of the cases treated since 1929 in the Roentgen Institute at the University of Zurich 144 were analyzed. Only preliminary figures can be given since no observations have been made extending over a five year period. In 55 per cent of the patients the local tumor responded well to the treatment. A comparison is also given of the results obtained in Zurich from 1919-1928 with those obtained in other clinics. The author concludes

that the protracted fractional dose method is the method of choice for treating tumors in the epi- meso-, and hypopharynx, it should also be considered in tumors of the larynx

ERNST A. POHLE, M D, Ph D

PARATYPHOID OSTEOMYELITIS

Paratyphoid Osteomyelitis A Report of Two Additional Cases J Ross Veal and Elizabeth M McFetridge Jour Bone and Joint Surg, April, 1934, 16, 445-450

The authors report two additional cases of paratyphoid osteomyelitis and discuss the etiology, pathology, diagnosis and treatment of this condition.

While typhoid osteomyelitis is not usually overlooked, that form of bone disease caused by *B paratyphosus* is generally not considered as a diagnostic possibility Webb-Johnson, in 1,038 cases of paratyphoid fever, observed only two cases of bone involvement, both of them arthritic Although Winslow saw 100 cases in 1916, in no case did he find any evidence of bone complication

Paratyphoid osteomyelitis may be quite acute and accompanied by all of the usual signs of acute osteomyelitis, or it may be insidious in onset and chronic in course. While the lesions may be single or multiple the single form is more common Temperature pulse, respiration and blood count are variable as in the case of staphylococcal or streptococcal osteomyelitis

In the early stage roentgenograms may reveal a thickening of the periosteum, which is not typical It has been noted that the primary involvement usually is located in the diaphysis rather than at the juxta-epiphyseal region Diagnosis depends upon the characteristic agglutination tests and identification of the organism from the blood stream or from the discharge from the bone lesion In the cases reported by the authors the agglutination tests were positive as was the blood culture in one case and *bacillus paratyphosus B* was identified in the pus removed from the bones in both cases

The treatment consists of surgical drainage when pus is present The use of vaccine therapy as an adjunct to surgery is considered a wise precaution

J N ANÉ M D

PELLEGRINI-STIEDA SYNDROME

Calcification of the Tibial Collateral Ligament A Report of Forty two Cases Jerome G Finder Jour Am Med Assn April 28 1934, 102, 1373-1375

The first case was reported in the English literature in 1933, previous to which 150 cases had been recorded in European publications Köhler (1903), Pellegrini (1905), and Stieda (1907) were the first to report and study the disease Roentgenograms reveal a semilunar shadow overlying but usually distinctly separate from the medial femorocondylar angle Depending on the degree of ligamentous involvement the shadow

may be crescentic triangular or fusiform It may be limited to the condylar region or extend distally toward the joint The author also describes three other groups showing central areas of calcification, a pea-sized nodule in the mid portion of the ligament, combined areas of calcification, combining characteristics of Groups 1 and 2 and irregular areas of calcification Injury is almost invariably the inciting factor Conservative measures are usually advocated, rest during the acute stage, physical therapy later

C G SUTHERLAND, M D

PEPTIC ULCER (DIAGNOSIS)

What Causes Peptic Ulcer? Editorial British Med Jour, April 21, 1934 No 3824, 719, 720

A large variety of theories of the causation of peptic ulcer has been advanced, such as infection, interference with blood supply, trauma allergy vitamin deficiency, and disturbance of endocrine function Those hypotheses based on experimental evidence are considered weak, as the type of ulcer produced experimentally has usually been acute, superficial, and rapidly healing whereas we are more concerned with the type of ulceration which has as essential features deep destruction and a most persistent chronicity However, Mann and Williamson produced these chronic ulcers experimentally These workers believed peptic ulceration occurred only in areas of mucosa exposed to the action of acid gastric secretion and they were able to induce persistent ulceration beyond the pylorus by diverting the alkaline secretions which normally neutralize the gastric contents at this point

Florey and Harding showed that the duodenal mucosa plays an important rôle in neutralizing acid from the stomach, and believed that an insufficiency of this secretion may be a factor in producing peptic ulceration These experiments have all been repeated many times by other investigators with the same findings This fact, with the constant finding of hyperchlorhydria in the subjects of this disease, would indicate that the chief factor in maintaining peptic ulceration is the local action of gastric secretion

With the weight of evidence already on hand pointing to the local action of the gastric secretion it is considered a little surprising to find it seriously suggested that peptic ulcer is due to a specific infection Saunders Holsinger and Cooper, in a recent publication reiterate the original findings of Saunders to the effect that a constant and distinct type of streptococcus can be cultivated from peptic ulcers and adduce evidence that feeding cultures of this streptococcus to dogs subjected to one of the surgical procedures devised by Mann and Williamson increases the subsequent incidence of ulceration and alters its type While it is not inconceivable that a strain of streptococcus may multiply in the base of a preformed ulcer and even give rise to agglutinin formation this would not prove that this particular type of organism produced the ulcer

J N ANÉ M D

THE PROSTATE

Prostatic Resections, with Special Reference to Poor Surgical Risks A E Goldstein and Charles S Levy *Am Jour Surg*, March, 1934, 23, 452-456

In the hands of the experienced, this is a logical surgical procedure for selected cases, principally small lobes and vesical contracture. The authors reached the following conclusions regarding their experience with prostatic resection:

Good surgical risks with very large prostatic adenomas should be prostatectomized. Poor surgical risks, regardless of the size of the prostate, are best amenable to prostatic resection.

The operative procedure of prostatic resection can be performed on poor surgical risks with greater safety than can the open operation.

On poor surgical risks with prostatic obstructions one should do prostatic resections rather than resort to a catheter or suprapubic tube life for the patient.

DAVIS H PARDOLL M D

Prostatectomy with Closure Five Years' Experience. S H Harris *British Jour Surg*, January, 1934, 21, 434-452

The article presents the author's results obtained during the five years' currency of this operation. The number of cases submitted to prostatectomy was 371, deaths 10, mortality rate 2.7 per cent.

The operation is decidedly not one for the occasional prostatectomist, but the technic will present no insuperable difficulties to those experienced in this branch of surgery. The essential features of the operation are the immediate control of hemorrhage by suture, the re-formation of the prostatic urethra and obliteration of the prostatic cavity combined with immediate closure of the bladder and abdominal wound.

In addition to the improvement of mortality, morbidity, and operability rates, manifested by this operation as compared with other widely practised methods of suprapubic prostatectomy, this operation also completely obviates post-operative recurrence of obstruction. Further, the various septic manifestations, which have been the bugbear of prostatectomy, have almost completely disappeared.

DAVIS H PARDOLL M D

THE SKIN

Quality of Radiation and Skin Reaction G Schwarz and A Frank *Strahlentherapie*, 1934 50, 145-156

The influence of the quality of radiation on the skin reaction was studied on human skin (thigh). The following qualities were used: 178 K.V., 0.5 mm Cu + 2 mm Al, H.V.L. in Cu = 0.95 mm; 160 K.V., 0.5 mm Cu + 1 mm Al, H.V.L. in Cu = 0.737 mm; 120 K.V., 1 mm Al, H.V.L. in Cu = 0.13 mm; 110 K.V., 1 mm Al, H.V.L. in Cu = 0.133 mm. Since "threshold" erythema and erythema of first degree

are difficult to define the authors chose a marked reaction, i.e., dermatitis sicca and exudativa. This necessitated the administration of high doses in a single sitting (1,600 r). All factors remained the same in the exposure of two comparative fields except the wave lengths. For instance, one experiment was conducted under the following conditions: right thigh received 1,600 r at 160 K.V., 0.5 mm Cu + 1 mm Al, 3 ma H.V.L. in Cu, 0.74 mm, 40 r per min, 20 cm FSD. The left thigh received 1,600 r at 110 K.V. through 1 mm Al at 2 ma, H.V.L. in Cu, 0.13 mm, 40 r per min, 20 cm FSD. The applied dose was controlled by means of an integrating dosimeter during the entire length of the exposure. Photographs are appended showing the reactions at various intervals after the treatment, up to 72 days.

An analysis of the results shows that the roentgen dermatitis was much more pronounced if harder rays or, in other words, radiation of shorter wave length was used. The authors emphasize that these results contradict the viewpoint that roentgen rays are the most injurious to the skin the softer they are.

ERNST A. POHLE M D, Ph D

Ointments for Protection against Light Exposure. Richard Hahn *Strahlentherapie*, 1934 49, 181-222

The author tested with physical and biologic methods the efficacy of 29 ointments sold in Germany for protection against sunburn. He found that seven of the ointments served the purpose very well but that better preparations must be developed. For details, see the numerous tabulations and graphs in the original article.

ERNST A. POHLE M D, Ph D

THE SKULL

The Pineal Body Roentgenological Considerations Jacob H Vastine *Am Jour Roentgenol and Rad Ther*, August, 1933 30, 145-155

The function of the pineal body is still a subject of much controversy, however what is of great importance to roentgenologists is that it becomes sufficiently calcified for roentgenologic visualization in a large percentage of cases in adults (52 to 60 per cent of adults over 20 years, and 15 to 20 per cent of individuals under 20). When calcified and thus visualized it may be shown to be displaced either by tumor or by trauma with intracranial hemorrhage. Sources of error in considering displacement are: (1) improper positioning of patient with resultant imperfect lateral or anteroposterior films being obtained, (2) unusual skull shape particularly dolichocephaly, (3) unilateral calcification in the falx cerebri, (4) calcification in tumors near the pineal, with the pineal not calcified, (5) areas of calcification due to psammoma phleboliths etc.

The writer discusses pineal tumors and warns against the use of encephalography because of increased intracranial pressure. These tumors are rarely localized

ante mortem, and, similarly, they have rarely been reported as showing roentgenologically demonstrable calcification

J E HABBE, M D

The Roentgen Findings in Suppuration of the Petrous Apex (Petrositis) Henry K Taylor Am Jour Roentgenol and Rad Ther, August, 1933, 30, 156-162

Suppuration in the apical portion of the petrous pyramid is a complication of an acute otitis and can be recognized clinically and roentgenologically. Clinically, there is profuse otorrhea occurring after a period of cessation, following a simple mastoidectomy, pain along the distribution of the ophthalmic branch of the fifth nerve, and low grade sepsis. Roentgenologically by infero-superior projection of the base of the skull one may see diminished aeration, deficient trabeculations, atrophy, perforation, and finally destruction of apical contour. The illustrations show clearly the pathological changes described by the author

J E HABBE, M D

THE SPINE

The Roentgen Diagnosis of Spinal Deformities M L Sussman and M A Kugel Am Jour Roentgenol and Rad Ther, August, 1933, 30, 163-176

All spinal deformities examined roentgenologically should be studied with regard to shape of intervertebral discs, presence of bone reaction, presence of general atrophy of spine, and manifestations of disease elsewhere, as well as the shape and appearance of the vertebrae proper. Deformities are classified by the authors into the following groups: congenital, developmental, traumatic, infectious, metabolic, blood dyscrasias, primary tumors, metastatic tumors, pressure atrophy and unclassified (Hodgkin's disease). According to the authors a longitudinal diameter of a vertebra shorter than the corresponding diameter of a vertebra above it is to be considered as absolute evidence of pathologic involvement of that smaller vertebra, congenital anomalies excluded. The presence of a localized hypertrophic arthritis with wedging of the body and without narrowing of the discs is considered usually to indicate an old compression fracture. The Kummell-Verneuil syndrome is traumatic collapse of a single body with a general malacia of the spine in addition. The characteristic appearance of osteomyelitis (staphylococcus, pneumococcus, meningococcus, *B. typhosus* or *paratyphosus*, *melitensis* or *proteus*) is a localized ragged hypertrophic spondylitis, with uniform narrowing of the adjacent intervertebral disc and slight wedging of the body progressing later to collapse, often with destruction of the vertebral appendage. Metabolic disorders (amyloid disease, the xanthomatoses, and possibly Niemann-Pick's disease) give characteristically a narrowing of the vertebral body with either wedging as a lenticular shape with either no change or a widening with

spherical shape of the disc. A similar appearance is seen in Paget's and von Recklinghausen's disease.

A large tabulation is appended showing the frequency of changes in the bodies, discs, and appendages, in the various conditions described.

J E HABBE, M.D

Roentgen Observations in Vertebral Osteomyelitis and Spondylitis Infectiosa H Sternberg Fortschr a d Geb der Röntgenstrahlen 1934, 49, 32-56

Roentgenologic, clinical, and pathologic findings in non-tubercular inflammatory conditions of the spine are discussed, especially subacute benign vertebral osteomyelitis and chronic infectious spondylitis. The following clinical entities are considered separately: Acute vertebral osteomyelitis, chronic vertebral osteomyelitis, subacute vertebral osteomyelitis, acute infectious spondylitis, chronic infectious spondylitis. Each clinical entity is illustrated with case reports. Then follows the résumé of the observations and a review of the pathologic anatomical basis for the clinical conception. Finally, the differential diagnosis between vertebral osteomyelitis, infectious spondylitis and tubercular spondylitis is discussed with some detail.

It is stated that acute vertebral osteomyelitis, while rather rare, always presents a very serious disease, with a poor prognosis on account of the early extension of the infection to the meninges. While an early diagnosis might lead to sufficiently early surgical interference, roentgenologic symptoms cannot be found sufficiently early, and even in subacute cases it requires from three to eight weeks before vertebral destructive processes can be demonstrated roentgenologically.

Concerning chronic vertebral osteomyelitis very few reports are found in the literature. Statements repeatedly made by Oehlecker concerning chronic vertebral osteomyelitis are emphasized that "it is important to investigate more carefully so-called cases of tubercular spondylitis which show formation of ridges, bridges, and spurs or a striking sclerosis of bone." Not infrequently such cases should be diagnosed roentgenologically as chronic vertebral osteomyelitis of non-tubercular etiology. The case illustrating this clinical picture demonstrating a chronic streptococcus spondylitis at two levels of twelve years' duration, finally terminating with amyloidosis, also was considered and treated for long periods as a tubercular spondylitis. Subacute spinal osteomyelitis is characterized by an acute onset but leads to complete cure during a relatively short time. During the progress of the disease there occurs first a very marked demineralization of the affected portion of the vertebra, later a correspondingly extensive collapse, ultimately good regeneration of the deformed vertebral segment, at times with a varying degree of sclerosis. Large paravertebral abscesses may develop and undergo complete absorption.

The most interesting part of this paper concerns acute and chronic infectious spondylitis. These terms are interpreted as spondylitis occurring in connection with acute infectious diseases. Such vertebral disease very

regularly leads to symptomless or nearly symptomless recovery, especially the acute infectious spondylitis. Roentgenologically, one can observe shortly after the onset of the disease, which, as stated, always follows an acute infectious disease, limited destructive processes in the terminal plate of the vertebra or in adjacent spongy bone. This infectious process soon involves the intervertebral disc, which regularly undergoes narrowing. Healing of the infectious process starts soon with production of extensive reactive osseous spurs and ridges, which usually bridge over intervertebral discs and thus immobilize spinal segments. Such bony overgrowth in time may undergo much partial reabsorption.

Chronic infectious spondylitis in its roentgenologic manifestations resembles a milder degree of the acute disease and is discovered usually without any clearly shown connection to an acute infectious disease. It is said that the chronic infectious spondylitis is characterized by the fact that long periods, often years after an acute infectious disease, complaints concerning the spine are registered. On close inquiry it is not infrequently found that during the acute infectious disease pain in the back of considerable severity was observed during a short period, or that a "muscular rheumatism" developed following such an infection. Roentgenologically one finds an isolated reduction in height of an intervertebral disc, condensation of an adjacent vertebral portion, and some, at times fusing paravertebral ridges and spurs. No evidence of generalized chronic *deforming* spondylitis was observed in such patients, the disease always being limited to one segment.

Differential diagnosis on a roentgenologic basis, especially toward tubercular spondylitis, is often quite difficult. Errors are especially possible between osteomyelitic foci and tuberculosis in the central portion of the vertebral body—primary osseous form of tubercular spondylitis. Oehlecker considers appreciable sclerosis of the vertebrae with formation of paravertebral ridges and spurs, as characteristic for non-tubercular disease, but other authors have pointed out that occasionally such paravertebral ridges and spurs may also develop in cases of healed tubercular spondylitis, though such instances may be relatively rare.

This article should be read in detail by all those interested in traumatic and infectious diseases and especially by the men doing an appreciable amount of compensation work.

HANS A. JARRE, M.D.

Roentgenological Studies of the Intervertebral Disc
A Discussion of the Embryology, Anatomy, Physiology,
Clinical and Experimental Pathology. Edward L.
Compere and Donald C. Keyes. *Am Jour Roentgenol and Rad Ther*, June 1933, 29, 774-797.

The authors' experience confirms Schmorl's observation that the commonest lesion of the spine is prolapse of the nucleus pulposus into the spongiosa of the vertebral body. Pain or disability does not immediately follow such prolapse, although eventually, if loss of the semigelatinous fluid is extensive, a dehydration of the

disc follows, with resultant loss of the hydrodynamic function, which, in turn, causes increased stress on the bone and probably causes the lipping or osteoarthritis commonly observed. Any pathologic process which weakens the structures confining the nucleus pulposus, invades the nucleus or merely allows a portion of the nuclear material to escape, will interfere with normal spine function. There are no nerve fibers in the disc structure, hence subjective symptoms from involvement of the disc by trauma or disease are in proportion to the degree of involvement of adjacent structures. Cases of single and multiple nuclear prolapse, of calcification of the nucleus or metastatic sarcoma, tuberculosis, extensive degenerative arthritis of compression fracture, and of juvenile kyphosis are all described to show the primary and secondary changes demonstrable in the intervertebral disc. The illustrations include roentgenograms, museum specimens, sketches, and photomicrographs.

J. E. HABBE, M.D.

THE STOMACH

Absence of Left Diaphragm Associated with Inverted Thoracic Stomach. Zachary Sagal. *Am Jour Roentgenol and Rad Ther*, August, 1933, 30, 206-214.

Only eight cases of thoracic stomach have been reported in the literature. The most serious error (which may result fatally if thoracentesis is attempted) is in making a diagnosis of hydropneumothorax when actually one is dealing with thoracic stomach. The case reported by the author is that of a male aged 39 who first developed acute attacks of vomiting and marked thoracic compression at the age of 33. There had been only slight dyspnea on extreme exertion prior to this date. Physical examination showed distant breath sounds and a few râles in the left apex with all of the classical signs of hydropneumothorax on the left side. At that time a diagnosis of hydropneumothorax and presumptive pulmonary tuberculosis was made, although aspiration of the left chest had been twice unsuccessful. When examined later by the author a condition closely simulating hydropneumothorax was seen, but without evidence of compression of the left lung. The stomach was aspirated and on re-examination no fluid level was seen, the gas accumulation was much lower and the lung appearance in the upper chest was more normally clear. The left diaphragm could not be seen. When barium was given by mouth the stomach was found to lie in the left chest in an inverted position, the cardia being low and the pyloric end high up, the pylorus and proximal duodenum lying mesial and posterior to the cardia. Later study showed the upper part of the left side of the colon to be also in the left chest. The recurring acute attacks during adult life were attributed to a volvulus of the stomach which untwisted itself with certain changes in position of the patient or under the influence of a narcotic. There had been only four acute attacks in six years.

Warning is given against performing a thoracic paracentesis in the presence of a chest condition which appears to be atypical hydropneumothorax, without first determining by means of a barium meal, the location of the stomach and intestines

J E HABBE, M D

SPONDYLOLISTHESIS

Spondylolisthesis in an Infant Samuel Kleinberg *Jour Bone and Joint Surg*, April, 1934, 16, 441-444

While it is generally believed that the basis for spondylolisthesis is a congenital bilateral osseous defect in the pedicles between the superior and inferior articular processes it is also believed that the actual dislocation occurs during adolescence or adult life. About half of the cases with this condition of the spine give a history of sufficient trauma to tear or stretch the fibrous band bridging the defect, but many cases give no history of injury.

The author reports the case of a baby, 17 months old admitted to his clinic for treatment for congenital dislocation of the left hip. Routine x-ray examination showed marked spondylolisthesis with the body of the fifth lumbar vertebra displaced forward on the body of the sacrum to a distance of more than half of its antero-posterior diameter. The anteroposterior view showed also bilateral vertical laminar defects.

The author believes that the discovery of this case of congenital spondylolisthesis makes it likely that others are also congenital and necessitates a more careful and critical study of this type of deformity in relation to its exact onset, particularly in the absence of a history of a definite injury or sudden appearance of subjective symptoms.

J N ANE, M D

THE THORAX

Trauma as an Etiological Factor in the Production of Diseases of the Chest L. R. Sante *Am Jour Roentgenol and Rad Ther* July 1933, 30, 8-15

Pneumothorax following injury to the chest wall is usually associated with demonstrable rib fractures, occasionally however it follows injuries without evidence of bony trauma. Similarly a dry pleurisy followed by pleural thickening may follow injury with or without a fracture. Such pleural thickening can be demonstrated roentgenographically but not differentiated from pleural thickening of inflammatory origin.

Ordinarily penetrating wounds (stab or gunshot) are not serious unless infection supervenes or associated injury to the heart or abdominal organs takes place at the same time.

In only one condition does bacterial disease of the lungs seem to occasionally follow trauma—this is the so-called traumatic pneumonia.

Massive collapse of the lungs may occur following trauma to the chest wall or remote portions of the body.

In general, it may be concluded that any bacterial infection of the chest related to trauma is probably on the basis of a lowering of the patient's general resistance incident to trauma.

J E HABBE, M D

TUBERCULOSIS (SURGICAL)

An Inquiry into the Results of Surgical Treatment of Genital Tuberculosis in the Male Ralph O. Lee and Kenneth Bowes *British Jour Surg* January 1934, 21, 456-460

The authors followed up and analyzed a series of 89 cases of genital tuberculosis in the male, occurring in a ten year period.

The mortality of the disease appears to be about 20 per cent. Upward extension of infection to the urinary tract is rare. The recurrence rate after surgical interference is about 40 per cent, this figure not being influenced by the presence of a palpable vesicle before operation nor by its surgical removal.

Radical operation with vesiculectomy, while not affecting the recurrence rate in the other epididymis, seems to decrease the remote mortality. In this series radical operation has introduced an immediate mortality.

DAVIS H. PARDOLL, M D

TUMORS (DIAGNOSIS)

Adamantinoma of the Tibia Edgar Holden Jr., and John W. Gray *Jour Bone and Joint Surg* April, 1934, 16, 401-417

The authors report a case of adamantinoma of the tibia which occurred in an unmarried female school teacher, 36 years of age. The patient complained of pain and swelling of the left lower tibia of about two years duration. There was a history of trauma just before the onset of the pain. With the exception of a localized swelling over the lower tibia, the physical examination was essentially negative. The urinalysis and blood counts were normal and the Wassermann was negative. X-ray examination showed the presence of a destructive lesion 5 cm. by 3 cm. in size in the lower end of the tibia. It had somewhat the appearance of a multilocular cyst with the margins sharply delineated but not thickened. The entire diseased area was removed at operation and sections studied microscopically. The pathologic diagnosis made at this time was adenoma malignum.

Following the operation the patient remained well for about two years when, after turning the left ankle, pain and swelling recurred. Roentgenograms showed evidence of recurrence of the original tumor. The pathologic area was again removed surgically and the cavity curetted and chemically treated. The patient was then referred for x-ray therapy. The microscopic examination of sections of tissue removed at the second operation showed an infiltrating epithelial growth in a fibroblastic stroma. The pathologic diagnosis at this time was adamantinoma.

The adamantinoma is an epithelial tumor, fundamentally basal cell in type, in which all degrees of differentiation of the enamel organ can be found. The tumor develops from (1) the paradental debris, (2) the oral epithelium, and (3) the enamel organ. Cystic formation in the central network of the epithelial groups is almost a constant microscopic observation of adamantinomas.

Extramaxillary adamantinomas are considered uncommon. Such tumors occurring at the base of the skull have been reported and their origin traced to remnants of buccal epithelium in the neighborhood of the pituitary gland. The very rare adamantinomas of the tibia represent the only other location of these tumors extramaxillary.

J N ANÉ M D

THE UTERUS

Recurrence in Carcinoma of the Uterus. Felix Gál. *Strahlentherapie*, 1934, 50, 127-144.

The author groups the recurrences observed in uterine carcinoma as follows: recurrence after total hysterectomy, continued growth of microscopically small tumor cells left after radical operation, further growth of carcinoma particles seen at operation but not removable, growth of carcinoma particles distant from the field of operation, recurrence in carcinoma apparently healed by radiation therapy, recurrence in carcinoma after complete healing following radiation therapy. During the period from 1922 to 1931, 204 patients with recurrences who had been operated on somewhere else, and 48 of 206 patients with recurrences operated on in the author's clinic were observed. The treatment of these recurrences consisted of combined roentgen and radium therapy. The 48 cases from the author's own clinic are studied in detail. Of 125 carcinomas of the portio, 32 (or 25.6 per cent) recurred. The respective figures for 14 carcinomas of the cervix were 8 (or 57 per cent) and for 52 cases of carcinoma

of the fundus, 8 (or 15 per cent). Four (or 8.9 per cent) of these recurrences remained well over five years. At intervals of five weeks they received 50-60 mgm radium element for a period of 24 hours. One "carcinoma dosis" of roentgen rays was added. There was apparently no relation between the histologic structure of the tumor and the frequency of recurrence.

He also analyzed the 206 of his own patients as to the efficacy of the various treatment methods. It appeared that out of this group of cases who had radical operation, 28 were treated by radium prophylactically. Ten (or 35 per cent) recurred. Fifty received x ray plus radium and 15 (or 30 per cent) had recurrence. One hundred twenty eight were treated prophylactically by roentgen rays before operation and 23 of these (or 17.9 per cent) developed a recurrence. It seems, therefore, that prophylactic x ray therapy gives the best results. A number of selected case histories are found throughout the article to illustrate some of the author's observations. In conclusion he briefly discusses the fundamental difference between the surgical and radiological treatment of uterine cancer and its influence on the organism as a whole.

ERNST A. POHLE M D, Ph D

VARICOSE VEINS

Venography in Varicosities of the Lower Extremities. S. Chodkewitsch and A. Lasharew. *Fortschr. a. d. Geb. d. Röntgenstr.* 1934, 49, 143-147.

This is a brief technical description of the method and an only too short demonstration of the different types of varicosities encountered. The value of the method for determination of the type of desirable treatment is stressed (from 5 to 10 per cent sodium iodide, usually 20 c.c., occasionally more or less). Serial films are made during and after injection and with change of posture. Occasional thromboses were observed.

HANS A. JARRE M D

RADIOLOGY

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ACNE VULGARIS AND THE ROENTGEN RAYS

A STATISTICAL REPORT¹

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MEDICAL literature contains many articles on the subject of the x-ray treatment of acne vulgaris, but comparatively few of them deal with statistics based on a large amount of material that has been under observation for many months or years. Statistics can be misleading, but when properly compiled they are invaluable for the control of impressions. Our knowledge of results obtained with the roentgen rays in dermatology is based largely on impressions. For an accurate therapeutic appraisal, statistics from many workers are required. After a sufficiently large number of such statistical reports have been published, they can be compiled and analyzed in an attempt to formulate an accurate evaluation.

Years ago the senior writer believed that with the x-ray treatment of acne vulgaris, with the technic universally employed in this country, permanent cures amounted to 85 or 90 per cent, also, that not more than 20 per cent were cured in a reasonable length of time with methods other than x-rays.

Later, this impression was found to be erroneous, as shown by the following statistics based on treatment in private practice, which were published in 1927.²

Total number of acne cases treated with x-rays	244
Number of patients cured within four months	147 (60%)
Number of patients requiring more than four months	84 (35%)
Number of failures	13 (5%)
Number of patients who had one recurrence	37 (10%)
Number of patients who had a second recurrence	2 (0.8%)

In this group 60 per cent of the patients were clinically cured with one course of treatment, that is, in four months or less. However, recurrences amounted to approximately 11 per cent. The total number of permanent cures, with one course of treatment, is, therefore, reduced to about 50 per cent.

American dermatologists understand what is meant by conventional or routine x-ray treatment of acne vulgaris. For others we briefly outline such treatment. The dose is 75 roentgens (estimated with the condenser type of Victoreen ionization dosimeter with chamber in air) administered to each side of the face (back and chest when necessary) once weekly. The radiation is unfiltered. The kilovoltage ranges from 80 to 100, depending upon whether thermionic or mechanical rectification is used. The effective wave length is approximately 0.68 Angstrom unit. The approximate millimeters of half value

¹ Accepted for publication, Aug. 2, 1934.

² MacKee, G. M. X-rays and Radium in the Treatment of Diseases of the Skin. Second edition, Lea and Febiger, Philadelphia, 1927, p. 434.

layers in aluminum is 0.571. The maximum number of treatments is 16. Treatment is discontinued as soon as lesions cease to develop. Not infrequently only six, eight, or ten treatments are necessary. Irritating and stimulating topical remedies are interdicted. Attention is given to the general health, hygiene, diet, etc. Remedies by ingestion are given when necessary or advisable. All patients included in our x-ray statistics (in this article) were treated in this manner. At the beginning of treatment we carry out skin tests for toleration to x-rays. If toleration is low, the dose is reduced to about 37.5 roentgens. Also, during the course of treatment patients are tested each week for "impending erythema." This consists of noting increase of local vasomotor instability, with change of posture, pressure, heat, irritation, etc. "Impending erythema" calls for cessation of irradiation or reduction of the dose. It may be added that a change from routine treatment is seldom necessary.

In the statistics recorded above, the patients requiring more than four months were those who still had a few lesions and who required strong topical remedies and general medical attention to complete the cure after x-ray treatment was discontinued.

The subjoined statistics were compiled in 1927 also; they comprise patients who did not receive x-ray treatment and who were observed for long periods.

Total number of patients treated without x-rays	72
Number of patients cured within six months	16 (22%)
Number of patients cured in one or two years	29 (40%)
Number of failures	27 (38%)
Number of patients with one recurrence	8 (11%)
Number of patients with a second recurrence	1 (1.5%)

Of these patients, 22 per cent were clinically cured in six months, 40 per cent in one or two years. Recurrences amounted

to 12 per cent. The final result is 50 per cent permanent cures in two years or less as compared with a like number of permanent cures with x-ray treatment in four months or less. It is possible that some of these one- and two-year cases might have been cured spontaneously in that length of time.

In this short report no attempt is made to exhaustively review the literature. The subjoined statistical reports, with which we are familiar, are from the medical literature of this country. Howard Fox³ reported 191 cases of acne treated with x-rays, 111 of which were cured, 47 practically cured, 27 improved but did not continue treatment, 2 failures, and 4 recurrences. Maurice Brown⁴ reported 36 cases, with 20 cures, 16 very much improved, and 7 recurrences.

Michael's⁵ technic was about the same as ours. He also reviews the literature prior to 1928. In that year he published the following statistics. The total number of patients with known end-results was 191. Of these, 101 (53 per cent) were cured with one course of treatment, 23 (12 per cent) were greatly improved, 67 (35 per cent) of the cured cases relapsed. After a second course of treatment, final success was obtained in approximately 85 per cent of the cases. Hazen and Eichenlaub⁶ report on 175 cases. They used about 144 roentgens every second week. There were 7 failures and 39 recurrences. With conventional technic, Crutchfield⁷ had 9 recurrences in a series of 96 patients, two-thirds of whom were cured with a second course of treatment. McCafferty and McCarthy⁸ in a series of 70 patients, report 10 per cent recurrences. Lord and

³ Fox, Howard. *Arch. Dermat. and Syph.* January 1924, 9, 13.

⁴ Brown, Maurice. *Arch. Dermat. and Syph.* June 1925, 11, 764.

⁵ Michael, J. C. *Arch. Dermat. and Syph.* May 1923, 17, 604.

⁶ Hazen, H. H. and Eichenlaub, F. J. *Arch. Dermat. and Syph.* November 1921, 4, 671.

⁷ Crutchfield, E. B. *Texas St. Jour. Med.* November, 1923, 19, 395.

⁸ McCafferty, L. K. and McCarthy, C. L. *New York Med. Jour. and Record* March 1925, 121, 285.

Kemp⁹ published an excellent paper in 1931 in which they carefully analyzed the results obtained by the x-ray treatment of 406 acne patients, 247 of whom were followed for a sufficient length of time. Their technic was similar to ours. Approximately 75 per cent were cured or greatly improved, about 25 per cent had a recurrence, half of which were mild and half severe.

Recently, we have examined our office records covering a period of twenty years and the clinic records over a period of eight years. There were, in all, 5,376 cases of acne vulgaris, of which 606 patients received x-ray treatment and were followed through. Many more began x-ray treatment but failed to continue, and therefore, are not included in this study. Table I shows that only 13.7 per cent of the 5,376 patients received x-ray treatment. This is in accord with the gradually increasing belief that it is unnecessary and undesirable to treat all or most cases of acne with x-rays. There are definite reasons for this trend, a trend that is to the credit of modern dermatology and medicine. It is the result of a better general knowledge of medicine and of the general medical management of the disease, and a better appreciation of the advantages and limitations of the various therapeutic methods and combinations thereof. It is not due to untoward results nor to low x-ray efficacy. In this connection, however, it must be admitted that the x-ray treatment of acne is more hazardous than other methods, especially when the treatment is administered by those who lack skill or who are careless. To a constantly increasing degree dermatologists are using x-rays less as the path of least resistance, or as a source of remuneration. More of them try conventional dermatological therapy first, holding x-ray treatment in reserve. Better judgment is being used in selecting the best method for the individual case. So far as concerns patients, some prefer x-ray treatment

rather than topical remedies for various reasons, some neglect topical therapy and must be given x-ray treatment, while still others refuse x-ray treatment because of the fear of injury.

It will be noted that in the office records about 20 per cent of the patients received x-ray treatment, while in the clinic only about 7.5 per cent received such treatment. In explanation it can be stated that in the examination of 3,750 clinic records, it was found that although many more than the reported number began x-ray treatment, only 281 patients continued through to completion and these are the only ones used in this report. The percentage of private patients who complete the treatment is much greater than is the case at the clinic.

TABLE I

	Private	Clinic	Total
No. of case records examined	1 626	3 750	5 376
No. of cases treated with x rays	325	281	606
Percentages	19.9%	7.5%	11.2%

TABLE II

Sex	Private	Clinic	Total
Males	84 = 25.8%	95 = 33.8%	179 = 29.5%
Females	241 = 74.2%	186 = 66.2%	427 = 70.5%

Table II shows the number of males and females who received x-ray treatment for their acne. The ratio of females to males is about three to one in private practice, while at the clinic it is about two to one. This may indicate that acne is more resistant to medical treatment in females or it may mean that more females refuse treatment that is more disagreeable, troublesome, and less certain to cure promptly.

Table III shows the average age of the patients at the time x-ray treatment was given to be nineteen to twenty years—it does not mean that the acne began at this age. Approximately 65 per cent of the patients were at or just beyond puberty.

⁹ Lord L. W. and Kemp J. E. Southern Med Jour., October 1931, 24, 867.

Most of the patients in this particular group were about fifteen years of age

TABLE III

	Private	Clinic	Total
Average age	20	19	
No treated between ages of 14 and 16	203 = 62 4%	188 = 66 9%	391 = 64 5%

TABLE IV

Clinical results	Private	Clinic
Cured	132—40 6%	108—38 4%
Very much improved	88—27 0%	76—27 0%
Much improved	48—14 7%	39—13 8%
Total	82 3%	79 2%
Improved	41—12 6%	42—14 9%
Slightly improved	8— 2 4%	7— 2 4%
Failure	8— 2 4%	9— 3 2%
Total	4 8%	5 6%

Twenty four patients in cured group had 10 x ray treatments or less

Table IV shows the end-results of x-ray treatment of acne cases in both office and clinic. While considerable general medical attention is given our clinic patients, it is not so meticulous as in the office. The fact that the results are about the same in both office and clinic indicates, apparently, one of two things: either that the general medical care at the clinic is adequate, or that when dealing with a large amount of material general medical attention does not materially modify the end-results. Naturally, the latter statement does not apply to individual cases.

It is difficult to decide on the exact definition of the term "clinical cure" in these cases. In Table IV the word "cured" means that the patient had no lesions after cessation of treatment. "Very much improved" means that there was an occasional lesion, but no additional treatment of any kind was necessary. Under "much improved" are grouped the patients who, at times, have several lesions, especially at or near the menstrual periods. It is possible that many physicians would clas-

sify these three groups as cured cases. "Improved" means that after terminating x-ray treatment there was always one or several lesions, and that the patient had to use topical applications and other measures to complete the cure.

It is seen that in the office approximately 50 per cent of the patients were permanently cured in four months or less, about 28 per cent were practically cured, while in 15 per cent the affection was moderately active at times. It seems fair to state that in about 83 per cent of the patients the results were satisfactory, about 12 per cent were benefited to various degrees, while about 5 per cent failed to improve or were complete failures. The clinic figures are a trifle lower.

TABLE V

Recurrences	Private	Clinic	Total
Number	96	92	188
Percentage	29 5%	32 7%	31%

Table V records the relapses that occurred in a few months or within a year or two. They occurred most frequently in unhealthy persons, in persons whose hygiene and habits were not satisfactory, and in patients who received the x-ray treatment at or near puberty. Occasionally a relapse occurred in an adolescent or young adult for which no cause could be ascertained. While the recurrences are high, about 30 per cent, they were, according to the records, mild or moderate in all but about a dozen patients. They occurred in the first three groups of Table IV, therefore it is necessary to reduce the 83 per cent for the combination to about 53 per cent for permanently satisfactory results with one course of x-ray treatment. These figures correspond almost exactly with our 1927 statistics and they approximate the carefully compiled statistics published at about the same time by Michael, and Lord and Kemp.

In the entire series there were a few patients who developed local vasomotor instability during the course of treatment, but only in one instance was it marked

This patient showed evidence of an "impending erythema" after the sixth treatment, and in this one case x-ray treatment was discontinued permanently. In the others it was interrupted temporarily and resumed later with a smaller dose.

Our statistics include only those patients who were treated with the technic briefly outlined at the beginning of this report. In this series there were no untoward results. A few cases of x-ray sequelæ were noted with other technics. The question of scarring is not included in this paper because this subject was carefully studied in the Department of Dermatology, New York Post-graduate Medical School, and reported by Henry D Niles¹⁰

We tried a smaller dose on a very limited series of cases, with disappointing results. We are now experimenting with doses of about 37 r and 18 r, with and without strong topical remedies. It will be a year or two before the results are definitely known.

We attempted to analyze the clinic records of acne patients who were treated with methods other than x-rays, but the effort was useless because such a large percentage of patients failed to continue treatment or could not be checked for final results. In the office we are now able to report final results on 422 patients who did not receive x-ray treatment (Table VI)

TABLE VI

Total number patients treated without x-rays	422
Number patients cured within six months	85 (20.14%)
Number patients cured within two years	173 (40.99%)
Number of failures or patients only slightly improved	165 (39.09%)
Number of patients with one recurrence	58 (13.74%)
Number of patients with two or more recurrences	23 (5.5%)

It is seen that this larger series of cases

checks almost exactly with the smaller series of similar cases reported in 1927

SUMMARY

1 Of 5,376 records of cases of acne vulgaris, 606 patients were given x-ray treatment and continued such treatment until it was discontinued by the physician. Contact with these patients was maintained over a period of years.

2 Four hundred and twenty-two patients were treated without x-rays and remained under observation for several years.

3 Of the 606 patients who received x-ray treatment, approximately 50 per cent received permanent cures as a result of treatment extending over periods of from six weeks to four months.

4 Of the 422 patients treated without x-rays, about 40 per cent were cured in from six months to two years, most of whom required over eight months.

5 Without x-ray treatment, there were approximately 40 per cent failures, with x-ray treatment, failures amounted to about 5 per cent.

6 Complete clinical cures, and almost complete clinical cures were obtained in four months or less with x-ray treatment in about 83 per cent of the patients. Without x-ray treatment, about 62 per cent of the patients were clinically cured in from six months to two years.

7 Recurrences are more frequent when the cure has been effected with than without x-ray treatment—about 30 per cent with x-rays, about 13 per cent without x-rays. In the x-ray series many of the relapses occurred in patients who were below par in general health or who indulged in distinctly injurious habits, also, when the clinical cure was obtained at or shortly after puberty. For this last reason we prefer to hold x-rays in reserve until the patient is well beyond puberty.

8 Not a single patient in this entire series, treated with the technic herein outlined, developed any injurious result from the x-ray treatment.

¹⁰ Niles, Henry D., Arch. Dermat. and Syph., January 1933, 27, 89.

9 Fewer acne cases are treated with x-rays to-day than a decade or two ago. This is because conventional dermatological management is constantly improving, and because there is a better selection of method and combination of methods for the given case. This trend indicates better medical instruction and training, a better knowledge of the disease and its therapeutic requirements, and an increas-

ing disinclination to travel the path of least resistance, therefore, the trend should be encouraged.

10 Nevertheless, x-ray treatment from the standpoint both of statistics and clinical experience, offers the most certain method of obtaining a clinical cure and even a permanent cure, in the shortest time, especially when combined with adequate general medical attention.

DIFFERENTIAL DIAGNOSIS OF INJURIES OF THE SPINE¹

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THIS study has been undertaken in order to review the various types of injuries that involve the spine, and the anatomical anomalies and pathological conditions of the spine that may resemble injury, and thus cause confusion. This subject is of great interest in our everyday work among acute cases which are referred for roentgen examination. It is also of surpassing interest to anyone interested in industrial accident cases and medico-legal work.

To anyone studying this subject, it is soon apparent that there are a great number of conditions in the spine which have some points of resemblance to spinal injury. In order to differentiate anomaly and disease from injury it is imperative that one have a comprehensive theoretical and practical knowledge of the subject. The roentgenologist must equip himself adequately for this type of consultation work unless he is willing to leave it to others so qualified.

The development of roentgen apparatus and films has progressed to a point where the roentgenologist can now demonstrate the various parts of the spine to a degree impossible a few years ago. This technical improvement and recent admirable pathological and clinical studies have changed many of our old views and have added new concepts of disease.

Much of the subject matter contained herein has been compiled from the available literature. We have added to this from our experience and material wherever possible.

Compression Fractures of the Spine—This is the commonest type of fracture found in cases of spinal injury and comprises about 40 per cent of all spinal fractures. It is produced, in most instances,

by forcible hyperflexion or jack-knifing of the spine. This results in extreme pressure on the vertebral bodies with consequent collapse of one or more vertebrae. The area most frequently involved comprises the lower dorsal and upper lumbar vertebrae. The twelfth dorsal or the first lumbar vertebra shows the most frequent involvement, in our series either one or both of these being involved in over 15 per cent of the cases. The lower cervical spine is also a frequent site of injury in persons diving into shallow water. In certain instances more than one vertebra may be involved and an individual vertebra in various areas may be simultaneously involved. Among our cases we found 12 per cent of the cases with multiple fractures in one area and 11 per cent with multiple isolated fractures. These will be discussed later.

A history of injury together with pain referred to a local area, limitation of motion, local tenderness, and kyphosis at that point are the principal clinical findings in fractures of the vertebrae. A history of injury with any of the above signs should lead the clinician to call for a careful x-ray examination. The differential diagnosis should take into account a pre-existing unsuspected lesion, such as tuberculous spondylitis, malignancy, Charcot spine, hypertrophic spondylitis, and generalized osteoporosis with collapse of the vertebrae.

The x-ray demonstration of fracture of the body is the most important evidence in the diagnostic problem. This examination is of great importance in those early cases where the history of injury is so slight or uncertain that one is tempted to forego this expense. These unsuspected and untreated cases are the ones that may result in medico-legal problems or suffer serious disability. In cases where cord

¹ Read before the American Congress of Radiology at Chicago, Sept. 25-30, 1933.

lesions are present, it is also of extreme importance to determine the point for operative procedures and the pathological anatomy that will be encountered.

Compression fractures of the vertebræ are demonstrated roentgenologically to the best advantage in the lateral view in the typical case the body is compressed anteriorly so that it is triangular in shape. In the cases with considerable compression the diagnosis is made with ease, but in some cases the compression is so slight that the films must be of surpassing quality and even then one must search for minute breaks in the margins of the body. An angulation of the spine either posteriorly or laterally is also quite suggestive in spinal injury. The intervertebral disc tends to show little or no narrowing. This is a differential point in regard to tuberculosis, which shows early destruction of the disc. In some cases, however, the nucleus pulposus is ruptured and these may show varying degrees of narrowing of the intervertebral space. Healed cases also show narrowing or even obliteration of the space, with bony union of the vertebræ. In the anteroposterior view there is narrowing in the superior-inferior diameter and usually widening in the lateral dimension. There may be comminution, with lateral displacement of the fragments. With this condition there is usually seen an associated lateral angulation of the spine.

The reparative process is slow in its appearance since the callus is not abundant and forms slowly. Lipping around the vertebral margins, similar to the changes seen in hypertrophic arthritis, is usually seen after about three months—an attempt by Nature to immobilize the spine at this point. The amount of this bone proliferation is influenced by the care with which the spine has been immobilized and by postural influences. In older persons these changes are more pronounced. In early uncomplicated cases good functional results may be expected in from four to six months when treated by recumbency, with spinal immobility in hyperextension fol-

lowed by gradual activity with a brace or corset. Physical therapy during the latter weeks is of considerable aid. Operative procedures are usually reserved for those cases that do not respond to the conservative treatment, or in which there are extensive fractures of the body and lamina. Operation is also done occasionally as a time-saving measure in order to shorten the period of convalescence. Harbaugh and Haggard (9) state that the results, in fractures of the spine, seen before the California Industrial Accident Commission, indicate practically the same degree of permanent disability from operative and non-operative treatment.

Fracture of Transverse Processes—Fractures of the transverse processes are most frequent in the lumbar area. They may be produced either by direct violence or by indirect injury caused by extreme muscular pull, produced by hyperextension, with rigidity of the extensor muscles of the spine. Wilmoth (21) believes that the quadratus lumborum is the muscle which has the greatest influence in the production of these fractures. He reports 16 cases of fractures of the transverse processes of the lumbar vertebræ. The muscular pull is also of considerable importance in causing displacement of the fragments after fracture has taken place.

Deep palpation usually discloses pain at the site of the fractures. Movement of the back also causes pain, especially movements which require the use of the muscles of hyperextension and flexion. In certain instances the symptoms are slight and are thought to indicate only a strain.

The x-ray examination will prove to be of great aid in making the positive diagnosis and will show the amount of displacement of the fragments. In most instances these fractures are not associated with fracture of the vertebral body. We found that in 8 per cent of our cases of fracture of the vertebral body there were associated fractures of the transverse processes. Certain text-books state that these fractures of the transverse processes

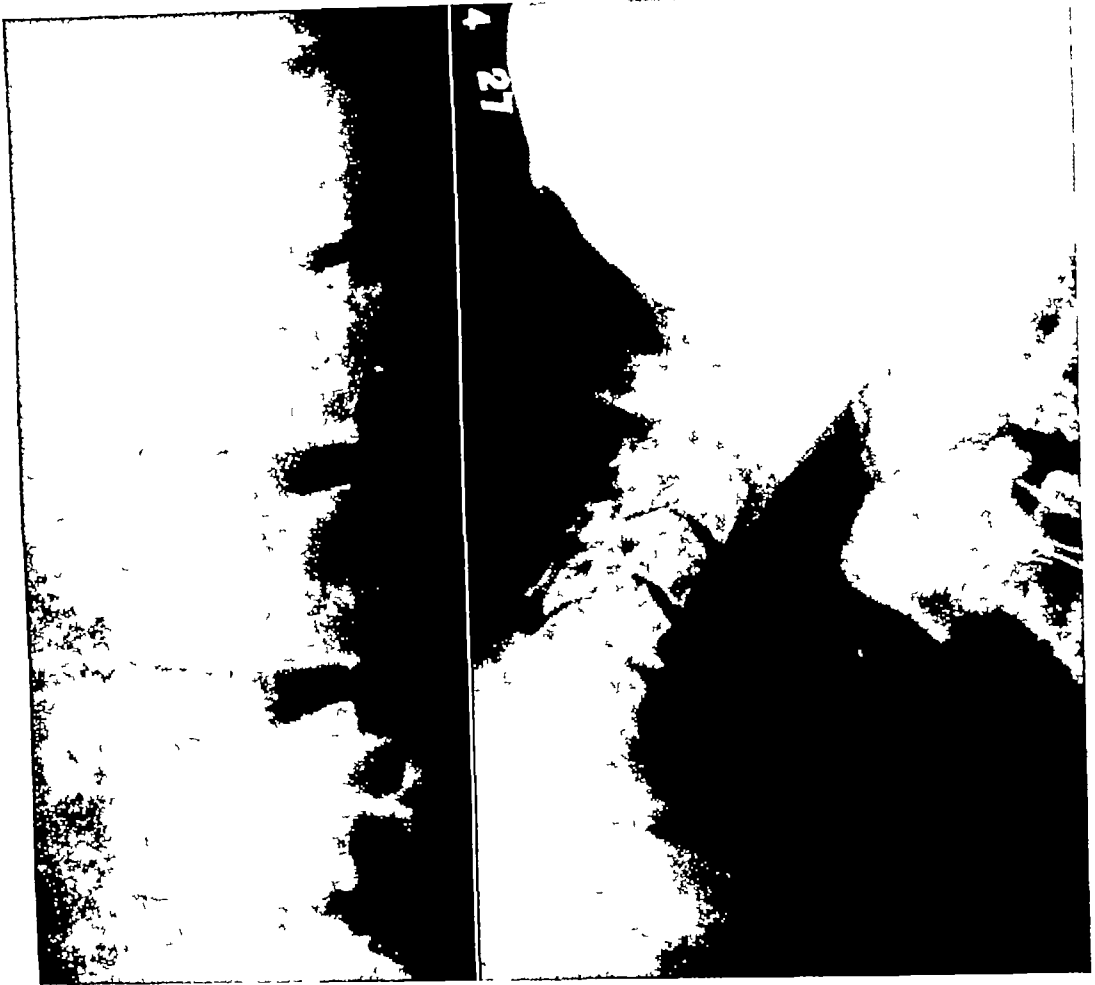


Fig 1 Compression fracture of two isolated vertebrae with two normal intervening vertebrae

Fig 2

Fracture involving laminae of the second cervical vertebra. There may be seen a fracture of the mandible

are relatively infrequent, but we believe that if a careful roentgen examination be made of all spinal injuries it will be found that they are not uncommon. We have 58 such cases in our files at the present time and have seen many others. Differential diagnosis usually lies between fracture and rudimentary lumbar ribs; the latter usually occur at the first lumbar vertebra and have an eburnated border where they articulate—they very seldom offer any real difficulty in diagnosis.

The fragments usually unite by bony union, except in those instances in which there is considerable displacement. At times transverse processes are seen which

are abnormally angulated or have an irregular contour, but one should be wary about calling these old fractures, as they are commonly seen in routine examinations of this area.

Fracture of the Spinous Processes—The commonest site for these fractures is in the cervical and upper dorsal area where the spinous processes are more slender, they are rather uncommon in the lower dorsal and lumbar areas. They are also more difficult to see in these areas, due to the thickness of the trunk which requires a relatively long exposure to clearly delineate the vertebral bodies. In our series of cases 80 per cent occurred

in the cervical area and 20 per cent in the lumbar area none involved the dorsal area

In our experience they have all been produced by direct violence, but Steindler (19) cites a case, described by Wolff (22), in which the fracture was ascribed to indirect violence due to extreme muscle contracture. Similar cases have been described by others.

Point tenderness can usually be elicited over the area of fracture. Accompanying fractures of the cervical area one finds crepitation, with mobility of the fragments, and the head may show restriction of movement. Immobilization is the only treatment necessary in uncomplicated cases.

Fracture of the Articular Facets—This fracture usually occurs in conjunction with dislocation or fracture dislocation of the spine, especially in the cervical and lumbar areas. According to various authors it may also occur as an isolated fracture and as such is frequently overlooked and the case treated for strain or lumbago. Mitchell (11) has recently reported five such cases, one of which was of such severity that removal of the fragment and spinal fusion was done. Two of them showed involvement of the superior articular facets and three of the inferior facets. Nichols and Shufflett (13) believe that non-union of anomalous epiphyses at this point may produce this x-ray picture, and report seven such instances. We have seen a number of cases such as might properly be called non-union of an epiphysis occurring at the tip of the facet, but it is significant that in the one case operated on by Mitchell there was fibrous union and microscopically no cartilage occurred between the fragments, as one would expect in the case of an ununited epiphysis.

These facet fractures in the lumbar area are produced by flexion and lateral bending with rotation. In the case of fractures accompanying dislocation there is usually displacement forward of the vertebra on the underlying vertebra. The most prominent symptoms are pain and restriction of motion, with muscle spasm. Treat-

ment usually consists of an application of a plaster cast or a Taylor back brace. If relief is not obtained by these measures, it may be necessary to resort to operative fixation of the affected area.

Fracture of the Neural Arch—Fractures of the arch are most common in the cervical area and are frequently associated with fracture of the spinous process. In some instances they will be found to be unilateral and in others, bilateral. They are often difficult to demonstrate satisfactorily, but they may be seen in the lateral projection in cases in which the fracture is bilateral and there is displacement of the fragments. In the anteroposterior view the films should always be made stereoscopically.

Fractures of the arch are relatively uncommon as compared to fractures of the other parts of the vertebra and are usually not of very serious import, as the fracture itself tends to relieve pressure on the cord.

Multiple Isolated Fractures—Multiple isolated fractures of the vertebrae, in which one or more normal vertebrae intervene between the involved ones, have been thought to be relatively uncommon. Schneider (18), in 1930, stated that he could find but 12 reported cases in the literature. To these, he added three of his own cases, all of which occurred in the dorsal vertebrae.

In our series we have 14 such cases, or approximately 11 per cent, which makes it a rather common occurrence. We believe that in cases of severe spinal injury the examination should embrace a considerable portion of the spine and frequently the entire spine.

In analyzing our cases we find two that show three isolated fractures in each, with normal intervening vertebrae. There is an average of four normal vertebrae intervening between the fractured ones. In 13 of the cases at least one of the involved vertebrae was in the dorsal area, in seven, one occurred in the lumbar area, and in three, one occurred in the cervical area. In five instances the fractures occurred in one section of the spine and in nine



Fig 3 Fracture of spinous process of sixth cervical vertebra Dislocation between sixth and seventh cervical vertebrae with forward displacement of the sixth



Fig 4 Non union of secondary epiphyseal center of ossification with the vertebral body These may easily be mistaken for fracture

cases they involved two sections. They are somewhat more common in the lower dorsal and upper lumbar areas, but the mid-dorsal area is also a fairly common area of occurrence.

The excellent results to be obtained in cases of vertebral fracture after proper treatment make it imperative that none of these multiple fracture cases be missed. It behooves us, therefore, not to examine the local suspected vertebra only, but to include large areas and in many cases the entire spine.

Pathologic Fractures—The conditions we have been describing are those which result from trauma. We find patients occasionally who show evidence of compression of one or more vertebrae yet have not

been subjected to trauma and in whom the symptoms appear to develop spontaneously or from very slight trauma incidental to our daily lives. In most of these cases the roentgen examination will disclose a pre-existing pathologic disease of the vertebrae which has produced bone destruction, with consequent weakening of the weight-bearing power of the bone. We call these pathologic fractures.

Bone tumors, both benign and malignant, are frequent antedating lesions. Osteomyelitis and tuberculosis also cause bone destruction, with collapse of the vertebral body. One of the most common causes of narrowing of the bodies is generalized decalcification such as that which results from hyperparathyroidism. In

some instances, in which in the early stages it has not shown local manifestations, this condition has been confused with vertebral fracture

There is no characteristic finding in pathologic fracture, as the picture will depend considerably upon the pre-existing disease. In general, however, the bone structure can be made out in fractures of normal bones, while in pathologic fractures, the normal bone structure will be lost and the characteristic findings of the original lesion may be discerned in many cases. Another diagnostic point which is of great aid is the type of compression of the vertebra. In the various types of pathologic fracture the compression is inclined to be uniform throughout in contradistinction to the triangular shape of the vertebra following trauma, in which cases the narrowing is all anterior, with preservation of the height of the vertebra posteriorly. This finding is by no means invariable but may be used as a valuable aid in diagnosis.

Kummell's Syndrome—This condition was first described by Kummell, who believed it to be a rarefying osteitis of the vertebra, but later he called it post-traumatic disease of the vertebra. He states that the patient had usually received a severe injury to the back, but the x-ray examination was negative at that time. The patient then entered on a period of freedom from symptoms in which he resumed his normal activities. After some months, the patient experienced pain and disability, with deformity of the back. X-ray examination at this time revealed a compression of the body of one or more vertebrae, with wedging anteriorly. The intervertebral disc at this time may or may not show narrowing.

This condition has long been a source of contention among medical men. In order to make the diagnosis, one must have a typical history and a characteristic roentgenogram. The roentgenogram must be negative at the time of trauma and positive later in the course of the disease, conditions which very few reported cases ful-

fill. In most of these cases the spine should not be called negative at the first examination because of inadequate x-ray examination. Frequently no lateral view was made, and the spine cannot be called negative without a lateral view.

O'Brien (15) gives it as his opinion that, "what Kummell has described is unrecognized, hence untreated, fracture of the spine—unrecognized because of no cord symptoms, inadequate or no roentgen examination, and the erroneous belief that if one can walk and has suffered only a slight trauma, one cannot have a fracture of the spine."

Rigler (16) reported one case which appears to fulfill the conditions laid down for this syndrome. At the time of the first examination there were fractures of the vertebrae at areas remote from the area in question, though later the deformity developed in an area that was roentgenologically negative at his first examination.

We have never seen a case that presented all the criteria which characterize this disease. We believe that while the condition may occur rarely, still in most instances it is due to an untreated injury which was missed because of inadequate x-ray examination.

Dislocation—Dislocation of the spine unaccompanied by fracture is almost always found in the cervical area, since the vertebrae in the dorsal and lumbar areas are interlocked by their spinous and articular processes in such a way that dislocation rarely occurs. In nearly all cases of dislocation affecting these areas there are associated fractures of some of these processes. Dislocation of the coccyx may occur and usually takes place at the sacrococcygeal junction. Oakman (14) described such a case and discussed the literature on this subject.

George and Leonard (8) believe that the atlas, axis, and the base of the skull should be considered as a unit area. They state that the most common lesion in this unit area is forward dislocation of the skull and atlas on the axis, with the skull and atlas



Fig 5 Congenital abnormalities of the spine and ribs



Fig 6 Ununited epiphysis of tip of the spinous process of the seventh cervical vertebra

retaining their normal relationship. When the dislocation involves the third cervical the members of the upper unit, consisting of the skull, atlas, and axis, are in normal relation to each other and are dislocated on the third cervical.

Dislocation of the cervical spine may be either unilateral or bilateral but the unilateral type is much more common and less serious. In the unilateral type the head is rotated to the side opposite the dislocation and there is abduction to the opposite side. There is muscle spasm but the head can often be manually replaced to the mid-line. The dislocation can frequently be replaced by continuous traction and manipulation. The bilateral dislocation is less common but more serious, and may frequently cause cord changes. There is marked pain and tenderness, with forward flexion. The reposition in the

latter type can be accomplished only by unlocking the facets by forcible traction and then replacing the displacement by manipulation.

In going over our series we found a uniform distribution of the dislocation throughout the cervical area. In all instances but one the dislocation was anterior, the exception to this being a lateral dislocation associated with fracture. In one-half of the cases there was an associated fracture either of the facets or laminae. There were two cases of dislocation of the coccyx and none of the dorsal or lumbar areas, aside from those with major fractures of the vertebrae. These may be classified more accurately under fractures with marked displacement.

Non-traumatic Dislocation of the Atlanto-axial Joint—In rather rare instances one sees a dislocation of the atlanto-axial ar-

ticulation in children following an acute upper respiratory infection Berkheiser and Seidler (1) have reported five such cases, one bilateral and four unilateral. In the unilateral anterior dislocation, the chin deviates to the opposite side, while in the posterior dislocation it deviates toward the same side. There is a torticollis deformity, with fixation and pain on motion.

It is difficult to obtain satisfactory films because of the deformity and, because of this, the diagnosis may be missed. With satisfactory films, Berkheiser and Seidler (1) state that the dislocation is shown as an overlapping of the articulating facets. The lateral view, in the anterior dislocation, shows the anterior arch of the atlas to be displaced forward with respect to the odontoid. Four of their cases were reduced by constant traction in hyperextension and the other by manipulation under anesthesia.

We have seen one case which responded satisfactorily to constant traction.

Spondylolisthesis—This condition is one in which there is usually a forward displacement of the fifth lumbar vertebra upon the sacrum. Less frequently the displacement may be between the fourth and fifth lumbar vertebrae or even between the third and fourth vertebrae. Spondylolisthesis is relatively common and is much more frequently seen since the lateral view of the lumbosacral area has been routinely used.

It is produced by the transmission of the body weight through the spine to the fifth lumbar vertebra which normally lies on an inclined plane. From the consideration of the articulation of the fifth lumbar vertebra it is obvious that this displacement must be either the result of an acute trauma or there must be an anatomical anomaly which has allowed the displacement to take place. We feel that it is nearly always the result of a congenital anomaly of the spine. The condition may either develop gradually, over an extended period, or acutely, from an injury which the already weakened spine cannot tolerate.

Congenital anomalies are quite common in the fifth lumbar vertebra, and Willis (20) has pointed out that the two centers of ossification for the neural arches may fail to fuse so that a false joint occurs between the pedicle and neural arches or between the pedicle and body. In a series of 748 spines examined he found a separate neural arch in 4.28 per cent of the cases. In 80 per cent of the affected cases the defect was bilateral. Chandler (3) believes that separation of the neural arch in the region of the isthmus is the usual cause of this condition, and in a series of 18 cases he found it in every case.

It is more common in males, especially in those who do heavy labor. The outstanding symptom is backache, which is aggravated by exertion and relieved by rest. Neurologic signs are infrequent because of the level of the lesion, but there may be referred pain and some parasthesia.

Physical examination reveals varying degrees of lumbar lordosis, with prominence of the upper posterior border of the sacrum and spinous process of the fifth lumbar vertebra. The body may appear to be shortened and the pelvis broadened. There may also be local tenderness, with muscle spasm.

The absolute diagnosis of spondylolisthesis depends upon the demonstration of the luxation of the fifth lumbar vertebra by means of the roentgen ray. In the anteroposterior view, the borders of the vertebral body are foreshortened, and in some cases the body can be demonstrated stereoscopically to lie anterior to the sacrum. It is in the lateral projection, however, that we obtain the exact information as to the relative position of the sacrum and the fifth lumbar vertebra. By comparing both the anterior and posterior borders of the vertebrae, one can get exact information as to the amount of displacement and tilting of the fifth lumbar vertebra on the sacrum. Tilting of the vertebra alone, without displacement, is not spondylolisthesis. In this view one can occasionally demonstrate a defect in

the arch The degree of displacement may vary from a slight displacement to one in which the body of the fifth lumbar vertebra lies almost entirely anterior to the body of the sacrum

Meyerding (12) recommends conservative treatment by means of casts, braces, and corsets and, if this is not satisfactory, spinal fusion should be done

Anatomical Anomalies which may Simulate Fracture—In addition to cases of frank bone injury such as are indicated above, there are many anatomical and pathological conditions which may be mistaken for fracture unless one has a large amount of experience and is constantly on the lookout for them Cases are constantly going through the courts as fracture cases, which are only anatomical anomalies or disease processes In many of these cases the correct diagnosis has been missed, while in others there is an honest difference of opinion, especially in chronic cases We will attempt to describe some of these conditions which may be mistaken for fracture, and point out their characteristics

Spina Bifida Occulta—Spina bifida is probably the commonest anomaly found in the spine Cushway and Maier (4) report that they found 156 instances of this condition in examining the backs of 916 supposedly normal men who were applying for railroad work Giles (7) reports its occurrence in 23.9 per cent of 1,122 cases This anomaly may involve any of the vertebræ from the cervical area to the sacrum, but is found more frequently in the lumbo-sacral area It may involve several of the vertebræ and frequently involves both the fifth lumbar vertebra and the sacrum By postmortem examination, Geipel (6) found nine cases of spina bifida of the atlas among 260 cases, the cleft varying from a simple fissure to an opening 6 mm wide

It is seen to best advantage by roentgen examination when the cleft is in the midline but may occasionally be demonstrated when the lateral portions of the lamina are involved In some cases the

body of the vertebra also shows an asymmetry, and there may be various other congenital variations associated with it In most instances the differential diagnosis of spina bifida and fracture presents no difficulty from the roentgen examination It is quite important for the roentgenologist to be able to recognize the difference between the chronic changes due to spina bifida and the recent changes characteristic of fracture

Bohart (2), from his study of a large number of railroad workers with known spina bifida, came to the conclusion that this condition is not a hazard in workers Men with this anomaly were not more liable to injury and disability than others not so affected

Sacralization of the Fifth Lumbar Vertebra—A frequent anomaly of the lumbo-sacral area is enlargement of the transverse process of the fifth lumbar vertebra, with either articulation or bony union with the body of the sacrum It may be unilateral or bilateral It should never be confused with fracture of the spine, but in several medico-legal cases of which we have had knowledge, it was described as fracture, apparently by an inexperienced person Bohart (2) has not found this to be a hazard among the railroad employees which he studied

Anomalous Ribs—Rudimentary ribs may occur at the level of the first lumbar or the twelfth dorsal vertebra, and they do occur in about 10 per cent of the cases of routine spine examination and may be confused with fracture of the transverse process In some instances they will be found to be unilateral, but frequently are bilateral They can usually be differentiated from fracture by the roentgen examination In anomalous ribs there is always an articulation which shows an eburnated border it may be rounded and smooth, in contradistinction to the sharp jagged edge seen in fracture of the transverse process

Cervical ribs may sometimes be confused with fracture of the transverse process, especially when the rib is short The

roentgen appearance of the articulation is, however, similar to that seen in the lumbar rib and should not lead to confusion with fracture of the transverse process

Ossification Abnormalities of the Vertebral Borders—Defective ossification along the borders of the vertebral bodies has recently been described by Hellmer (10). This results in a lack of fusion between parts of the epiphyseal centers and the vertebral body. It is found most frequently in the lumbar area.

The roentgen appearance suggests a small bone fragment separated from the body of the vertebra anteriorly, with a bony defect in the vertebra just beneath it. It may be either on the superior or inferior aspect of the body, although the former is more common. There may be irregular calcification between the body and the separated fragment.

The etiology is unknown but trauma would not seem to be a prominent factor. Hellmer (10) assumes from its general appearance that the defect is caused by abnormal ossification, which fails to unite parts of the secondary epiphyseal center of ossification and the body.

Differential diagnosis between this abnormality and fracture of the same area may be difficult, as the distinction between the two is not always clear-cut. In many instances, however, this abnormality may affect multiple vertebrae, and the adjacent portion of the body frequently has an appearance which is inconsistent with fracture.

Schmorl's Disease—Schmorl (17), on the basis of pathologic studies of over 8,000 spines, has described the nucleus pulposus of the intervertebral discs. He also described the herniation of the nucleus pulposus into the adjacent vertebra, a herniation which usually occurs when there are perforations of the cartilage plates or in cases in which they are degenerated. On the roentgen film they are shown as rounded depressions in the body of the vertebra just posterior to the mid-portion of the articular surface. There may be a similar process in a number of

adjacent vertebrae. Some irregularity and narrowing of the body of the vertebra may be present, especially if the process dates from adolescence or if there is a generalized osteoporosis. It is these latter cases that may suggest fracture, but the multiplicity of the lesions, the shape of the bodies, and the osteoporosis usually make the diagnosis clear. In these cases the disc is spherical in shape and the vertebral bodies assume a biconcave shape.

In another group of cases the nucleus pulposus is displaced posteriorly from its normal position. In these cases there may be some kyphosis, with narrowing of the vertebral bodies. This can be distinguished from fracture by the fact that multiple vertebrae are usually involved.

Anomalies of Development of the Vertebra—The development of the vertebral body will not be discussed, except to mention that any interference with the growth of the centers of ossification and their union will produce abnormalities of the body.

To this group of abnormalities, in addition to the anomalies mentioned elsewhere in this communication, may be added hemibody, complete absence of a body, fusion of two or more bodies, and rachischisis.

The Klippel-Feil syndrome is characterized by a congenital absence of one or more cervical vertebrae, with deformity of others. It is productive of great deformity of the neck. There is little likelihood of its being mistaken for fracture.

Pathologic Conditions Which May Simulate Fracture—In addition to anatomical anomalies which may be mistaken for fracture of the vertebrae, there are a number of disease processes which must be differentiated from fracture.

Spinal Tuberculosis—In tuberculosis of the spine the shape and appearance of the vertebra will depend upon the anatomical site of the infection in the vertebral body and the length of time the infection has been present, as has been pointed out previously by us (5). A vertebra which is the seat of a central type of infection of the body may collapse and show a trian-

gular shape very similar to fracture of a normal vertebra. In practically all cases of tuberculosis of the vertebræ, however, there is definite narrowing of the disc. This is not present in recent fractures of the spine, so that the differentiation is seldom difficult. In some old healed cases, with abundant bone production, the two conditions may be quite similar, as the disc may disappear in old fracture cases.

There is no conclusive evidence at hand which would tend to show that injury may be the inciting factor in tuberculosis of the spine.

Neoplastic Deformities—Neoplastic lesions are frequently found in the vertebræ and may cause deformities which must be differentiated from injury.

Metastatic carcinoma is by far the most common type of tumor found in the spine. It is divided into two types, depending upon the amount of bone destruction and proliferation, *viz*, (1) osteoblastic, (2) osteoclastic.

Osteoblastic carcinoma of the vertebra is manifested by an increased density of the bone, with loss of the normal trabeculation, so that the vertebra stands out sharply in comparison to the surrounding vertebræ. The shape of the body is usually maintained, so that there is very little chance of its being confused with fracture.

Osteoclastic carcinoma is characterized, in its early stages, by areas of lessened density representing bone destruction. These areas may progress until the structure of the bone is so weakened that it can no more support the body weight, and collapse occurs. In many cases the collapse of the body is shown as a uniform flattening. In some instances the destruction may be in the lateral portion of the body, in which case there results a lateral angulation of the spine at that point. In many cases it can be differentiated from traumatic fracture by the presence of metastases in other bones, and these should be sought. The type of destruction, however, will usually make the

diagnosis clear. Obliteration of the disc is unusual, except in late cases.

Osteogenic sarcoma is more difficult of diagnosis until, in the later stages, when the surrounding tumor, often containing areas of bone proliferation, will aid in determining the correct diagnosis.

Multiple myeloma is not common, but may produce very marked deformity of the vertebræ. There may be collapse of the bodies of a great number of the vertebræ, but in the early stages it is not unusual to see a single vertebra involved. We have seen two cases in which collapse of a single vertebra made the differential diagnosis from fracture difficult until other vertebræ showed similar changes.

Benign tumors, such as giant-cell tumors and cysts, are not commonly found in the spine, but the former may produce marked deformity and distress in the later stages. It is not likely to be mistaken for fracture.

Hyperparathyroidism—In cases of hyperfunction of the parathyroid glands there is mobilization of the blood plasma calcium, which is taken largely from the skeletal system, the great storehouse of calcium in the body. In such cases there is a generalized osteoporosis, with softening of the bones and resultant deformities.

In the spine the softened vertebræ are unable to maintain the body weight and various deformities result. There may be compression of the bodies of one or more of the vertebræ, especially in the mid-portion and lower dorsal and upper lumbar areas. This compression of the vertebræ is seen both anteriorly and posteriorly, with a biconcave narrowing quite different from the triangular shape seen in fracture. The intervertebral discs are not narrowed. There may be scoliosis and exaggeration of the anteroposterior curves of the body. The general picture does not simulate fracture to any great degree and the differentiation is not likely to be difficult. The generalized osteoporosis will usually aid greatly in making the diagnosis clear.

DISCUSSION

We have tried to list above most of the commoner types of spinal injury and the anatomical and pathological conditions that may be confused with injury. In most instances the differential diagnosis is not difficult. There are certain instances, however, in which, because of atypical findings, recourse should be had to all the clinical findings in the case. In many conditions the roentgen findings are not typical in the early stages and knowledge of the clinical findings will be the means of an early diagnosis. If one maintains a healthy skepticism and a proper balance of clinical judgment, he is not apt to read into the film false values.

Various clinical factors must be taken into consideration when expressing judgment on roentgen films of the spine. The age of the patient is of great importance and one must recognize the changes that characterize each age period. This applies especially to patients over fifty years of age in whom hypertrophic changes incident to age may be considered under the heading of a true or traumatic arthritis. A knowledge of these hypertrophic changes is of great importance in industrial accident cases, in which they are often attributed to injury. If the spine is examined immediately after injury and hypertrophic changes are present, their relation to the injury can be ruled out. If the patient is not seen until several months after the injury, these changes are frequently attributed to the injury. Hypertrophic changes, however, have a rather characteristic appearance. They begin at the vertebral margins and extend toward the spur on the body of the adjacent vertebra. These spurs very rarely unite unless there are other influences that change their characteristics. The bone proliferation seen after injury to the vertebrae is usually a protective mechanism and tends to bridge and immobilize the vertebrae, acting in a similar manner to a bone graft.

Occasionally cases of back injury are seen which are roentgenologically negative at the time of injury but which show partial or complete bridging of the vertebrae in the affected area after an interval of several months. Such a case represents a reparative process from a slight undetected injury to the vertebra and surrounding soft tissues, and is not similar to an arthritic change.

Very little difficulty is to be encountered in the diagnosis of true acute fractures of the vertebral body and its appendages, with the exception of the technical difficulties encountered in demonstrating the lesion clearly. It must be recognized, however, that the type of fracture and the portion of the vertebra involved will vary, depending upon the area of the spine involved. Thus, it is recognized that while compression fractures of the cervical and upper dorsal areas may occur, they are not the usual occurrence, and when present will often vary from the standard type of compression. In the cervical area fracture is usually an accompaniment of dislocation.

Patients who have had an injury some months before and those who have an indefinite or slight history of trauma often present a difficult problem, especially if there are changes in the spine which vary from the normal appearance. Often anatomical anomalies are incorrectly diagnosed as fractures. It is this class of case that is provocative of so much litigation in the industrial accident courts. In a great percentage of these cases there should never be any diversity of roentgenologic opinion, as the diagnosis is self-evident to any roentgenologist of experience. A considerable source of this confusion is the legal practice of allowing any physician to qualify as an expert in roentgenological diagnosis by his own statement. This practice can be overcome only by the medical profession setting up definite standards of specialism and encouraging the courts to adhere to these standards.

SUMMARY

A brief discussion of some of the clinical and roentgenologic features of injury of the vertebral body and appendages has been given. Most of the commoner types of anatomical anomalies that might be confused with fracture have been outlined.

A few disease processes that are sometimes confused with injury of the spine have been discussed briefly.

We have kept in mind throughout this discussion the medico-legal aspect of the subject and have referred to it occasionally.

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THE TREATMENT OF CHEST-WALL SECONDARIES IN BREAST CARCINOMA

A PRELIMINARY REPORT OF A NEW RADIUM TECHNIC¹

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FOLLOWING the surgical treatment of primary carcinoma of the breast, the problem presented by recurrent lesions in the skin and subcutaneous tissues of the chest wall has been one of great complexity and attended by many disappointments to the radiotherapist

a dose of roentgen rays which will be evenly distributed over the entire area and at the same time effective. In the opinion of the present writer, this problem is impossible if large areas are used, if numerous smaller areas are used there also arises the difficulty of joining these together so per

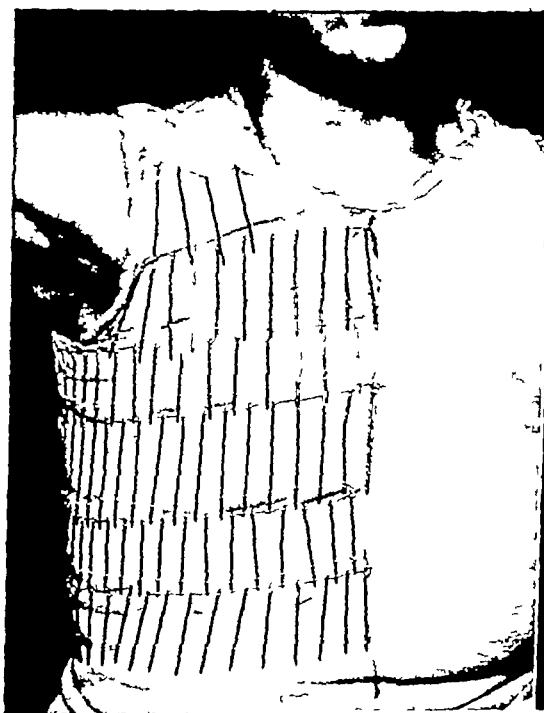


Fig 1 Front view showing the felt distance filter in place with the needles stitched to the felt. The needles are 'staggered' so as to obtain a more even distribution



Fig 2 A side view, showing the distribution of the jacket coming well around to the back. In this particular case there was no involvement high up in the axilla and the jacket did not extend into the axilla or along the arm. In some cases a sleeve is used extending throughout the axilla and down along the under surface of the arm as far as necessary

The first technical difficulty in applying x-rays to this problem is that of delivering to the curved surface of the thoracic wall

fectly that there shall be no bands or ribbons of tissue at the points where the various areas meet, which are either under- or over-treated

The next difficulty presented is the neces-

¹ Presented before the American Congress of Radiology at Chicago Sept 25-30 1933



Fig 3 Showing the finished jacket in place held by small adhesive straps for the purposes of the photograph. In actual treatment, these are heavily reinforced and the jacket is then held in place by means of padding and a flannel bandage.

Fig 4 Another view of the jacket in position

sity of delivering a comparatively heavy dose of radiation from a single portal of entry to the thin layer of tissue represented by the skin and subcutaneous tissues, beyond which lie the pleura and lung—structures which are moderately sensitive and comparatively easily damaged by roentgen rays. Apart from the occasional case of a highly sensitive tumor, the majority of these lesions are in the class of resistant tumors and require maximum doses if anything better than growth restraint is to be hoped for from the treatment. The layer of tissue thus represented does not usually exceed 3 cm in thickness and quite frequently is not more than 1 cm thick. Therefore, the technical problem which confronts us is to deliver within this thin layer of tissue an evenly distributed fully effective dose of high intensity radiation the penetration of which

will be limited to the chest-wall and will not damage the pleura or subjacent lung.

Because so much has been written on the mode of dissemination of secondaries in the chest-wall, it may be assumed that all are familiar with the prevailing theories, and time need not be taken up in discussing these. One point only may deserve further emphasis, *viz*, it must never be lost sight of in treatment that in between the visible or palpable nodules one should assume the presence of small islands of cells which are invisible to the eye and cannot be palpated with the finger, but any or all of which may develop if not adequately treated. Therefore, the primary object of treatment is to include every particle of skin throughout the chest-wall from the mid-line in front around the axilla, preferably to the mid-line of the spine posteriorly,



Fig 5 Showing the type of reaction which has been produced in very extensive cases. This reaction is slightly more severe than is necessary and is only used in very extensive disease. In this case it extended well up into the axilla and along the under surface of the arm, as well as over the whole chest-wall and supraclavicular area



Fig 6 A side view of the previous case demonstrating the extent of the reaction which in this case shows marked vesication

and from the clavicle above to the lower thoracic margin below

Having felt disappointed with the available methods some years ago, we undertook to treat this type of recurrence by unfiltered x-rays, and pushed this to the point of producing reactions of the first, second, and even third degree over the entire chest-wall. Because it was found that the penetration possible by using soft roentgen rays was not adequate for the purpose, and also that the reactions, which were painful, healed very slowly, we finally came to the conclusion that this was not the solution of this particular problem, although in many cases it offers a very useful adjunct to prevailing methods and probably should be made use of more frequently than is the case at present. It is doubtful however, if this method of treatment

should be used over areas larger than about six inches square, as the reactions are moderately painful and tend to heal slowly with considerable scarring and telangiectasis later

Finally, after numerous experiments, we adopted the method here reported which has now been in use for over a year and which seems to offer a satisfactory answer to more points in the problem than any other method which we have been able to discover up to the present time. The shortcomings of this method will be pointed out a little later

The method consists in fitting to the patient's body a radium applicator which we have called "the radium jacket." The foundation of this jacket consists of a layer of felt half a centimeter thick which is accurately fitted to the patient's body by

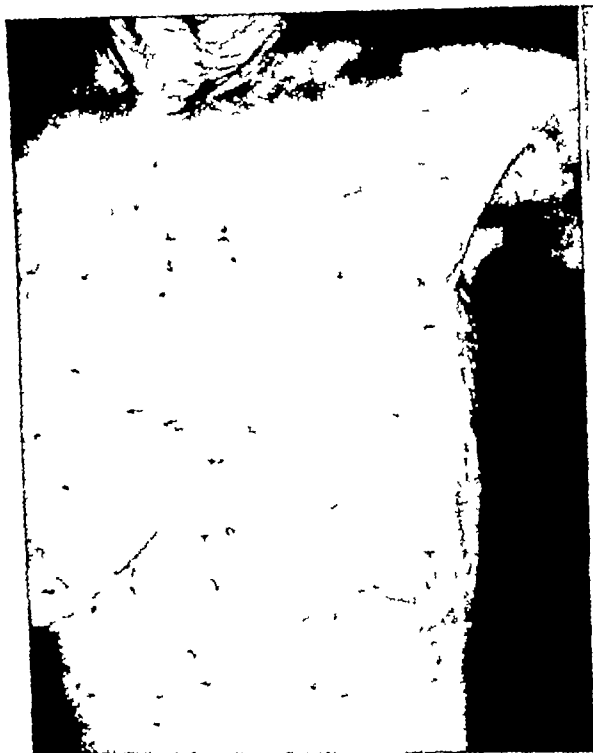


Fig 7 Showing the type of reaction produced by a modified jacket which did not extend over the whole chest-wall



Fig 8 Showing the type of case which is considered suitable for treatment. This one happens to be a primary lesion in which no surgical operation has been done and clinically is well on the way to becoming a cancer *en cuirasse*. This case is still under treatment having already made remarkable improvement following the application of the radium jacket

the dressmaker. To this, in the original form of the jacket, rows of radium needles were stitched as shown in the photograph, and accurately spaced from each other, so arranged as to provide a perfectly even irradiation of the entire chest-wall, from the mid-line in front around posteriorly as far as it was thought desirable to extend the jacket. In some cases this has gone as far as the mid-line of the spine. Later, in order to minimize the handling of needles and the stitching of them in place, containers were made by which the needles are slipped into pockets. These pockets are prepared in long strips and any number can be cut off to suit the individual case. They are laid on the felt and held in place by adhesive. When sufficient needles have been attached to the felt to cover the de-

sired area, the whole package is enclosed in pure gum rubber and sealed, and in this form is applied to the patient's chest. It in turn is bandaged in position, and the patient wears the jacket for a period of time which is determined by the radium content of the needles and the filtration of their wall. The needles, 60 mm, in length, which have been used for this purpose, contain three milligrams of radium element, and have a wall thickness of 0.8 mm of platinum of the standard platinum-iridium type. Approximately 100 of these needles are used in the full radium jacket and, with the very high filtration resulting in a hard gamma ray radiation and the distance from the skin, it is necessary to leave them in position from 90 to 100 hours in order to secure the desired effect.

The reaction which follows is a fairly severe first to second degree erythema with vesication and requires very particular care in its treatment. Occasionally, it is accompanied by temperature and constitutional symptoms sufficient to require the hospitalization of the patient. The treatment which has been found most satisfactory to the comfort of the patient is the application of a cream consisting of zinc oxide and castor oil, equal parts by weight, which is applied immediately following the removal of the jacket and until the reaction has entirely healed. The cream is applied thickly on gauze, the bandage being changed morning and evening.

Many modifications of this method of treatment are possible in patients in whom the secondaries are less extensive and who do not require a full jacket. For this purpose, local packs of any dimension or shape may be made up for application to local areas along the line of incision or elsewhere on the chest-wall. For deep involvement in the axilla, the radiation is not considered sufficiently penetrating nor is it recommended under these circumstances.

This treatment has been tried out in a different type of case, and the results so far secured are promising, but further information will be necessary in order to completely evaluate the method. These have been very advanced cases in which a prompt local recurrence would be expected from the ordinary surgical method of treatment. In addition, the length of time required for adequate pre-operative radiation was impossible owing to the patient's circumstances. Accordingly, a radical operation was done and the radium jacket applied immediately following the healing of the skin flap. The treatment is considered a prophylactic precaution against local recurrence in the chest-wall or axilla. Up to the time of the writing of this paper, there has not been a case in which local secondaries developed following the procedure outlined.

Results of Treatment—In the earlier cases treated by this method, the disease was of a very extensive nature and considered quite hopeless by all the available standard methods of treatment. In the majority of these cases, the local lesion disappeared following the application of the jacket, but later remote metastases developed and it is doubtful if the lives of these particular patients were prolonged to any extent by the treatment.

In a more favorable group of cases, however, in which remote metastases were not present and the local secondaries were less extensive, the results have been extremely satisfactory, and it has been felt that the method presented a definite improvement over existing available methods. The present report is offered as a preliminary one, and if the early favorable results are substantiated by further work, a more detailed report will be made at a later time.

Disadvantages of the Method—The two disadvantages of this method up to the present time are as follows:

- 1 In several cases there has been a rather severe constitutional reaction, accompanied by temperature and a moderate degree of shock which has required the hospitalization of the patient for several weeks.

- 2 If the treatment fails to control the disease, it results in a fairly marked degree of devitalization of tissue and subsequent treatments by any method are rendered difficult or impossible.

In spite of these and a number of other minor objections, the results in those cases which have been observed have been distinctly superior to anything we have seen in our own work by other methods of treatment. Also, it appears to offer at least an alternative method of treatment in a difficult field, having the great advantage of a highly penetrating hard gamma radiation, which can be applied over a very wide area and yet does not penetrate so deeply as to damage the underlying delicate structures of the lung and pleura.

THE CUMULATIVE DOSE WITH MULTIPLE FIELDS¹

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IN A recent publication (1) the authors endeavored to point out that when the protracted method of radiation is used, the mere statement of total dose gives insufficient information concerning the accumulation of the so-called radiation effect in the skin. It was also indicated that if increments of the order of those ordinarily used in therapy were applied at one-, two-, or three-day intervals, there resulted a condition of equilibrium in the area radiated, when the loss of radiation effect per day compensated the increment added on that day, but if the increment were larger a condition of equilibrium was not attained, and the cumulative dose curve reached a definite peak. The maximum value of this peak was arbitrarily selected as 2,000 r (tissue dose), which, according to Mattick (2), represents a very marked reaction of the skin, bordering on epidermolysis. No cumulative dose calculated using a loss coefficient of 0.08 per day for effective wave length of 0.16 Å, and charted in the previous paper, reached a peak or a condition of equilibrium exceeding 2,000 r.

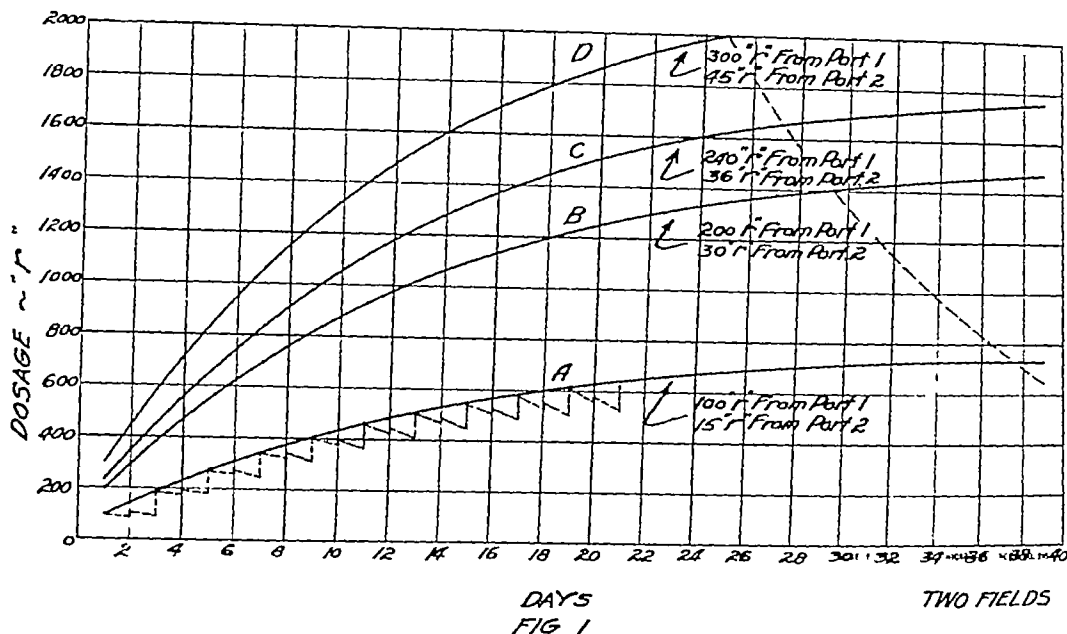
The present paper is a continuation of the first, but whereas the first paper dealt with the skin doses with single fields, this paper refers to the doses accumulated in the skin when multiple ports of entry are used in such a way that there is overlapping of the beams at the various ports. However, when calculating the doses accumulating in the skin under these conditions, the problem is more involved.

In the first paper, where one field was used, it was possible to calculate and construct cumulative dosage curves to fit actual working conditions. With multiple ports of entry, however, this cannot be

done, because with opposite fields, the amount of radiation penetrating to the opposite skin will depend on the target-skin distance, the field size, the diameter of the part irradiated, and to a lesser extent on the wave length, while with adjacent fields the amount of overlapping will vary depending on the proximity of the fields, in addition to the factors mentioned above. Therefore to construct standard curves for multiple fields which would be comparable to those published for one field, it would be necessary to make individual curves to satisfy all of the variables mentioned. We have, therefore, based our calculations on two-depth intensities representing no particular combination of factors.

When a beam penetrates an appreciable thickness of tissue, there is a change in wave length. It has been shown by Qumby and McNatten (3) that a beam of radiation having a half value layer of 0.45 millimeter of copper at the surface is changed in quality to one having a half value layer of 0.26 millimeter of copper after passing through 10 centimeters of tissue. Weatherwax (4) has shown that as the wave length changes the loss of radiation effect per day also changes. We should use, therefore, a larger loss coefficient for the beam from the second port, since its wave length has been increased due to the scattering process. However, in cases in which the diameter of the part irradiated is small, the change in wave length is slight, and therefore the use of the loss coefficient associated with the incident beam will produce an error so small as to be negligible. On the other hand, when the diameter is large, the change in wave length is greater, but in this case the relative intensity is reduced to such an extent that the use of the large coefficient

¹ Accepted for publication June 23 1934



with a small intensity would not change the net result sufficiently to warrant its use. Furthermore, the error resulting from this disregard of the variation in the loss coefficient with the wave length is on the safe side, since the loss is greater than that calculated and the actual cumulative dose is, therefore, slightly less than the calculated dose, leaving a margin of safety.

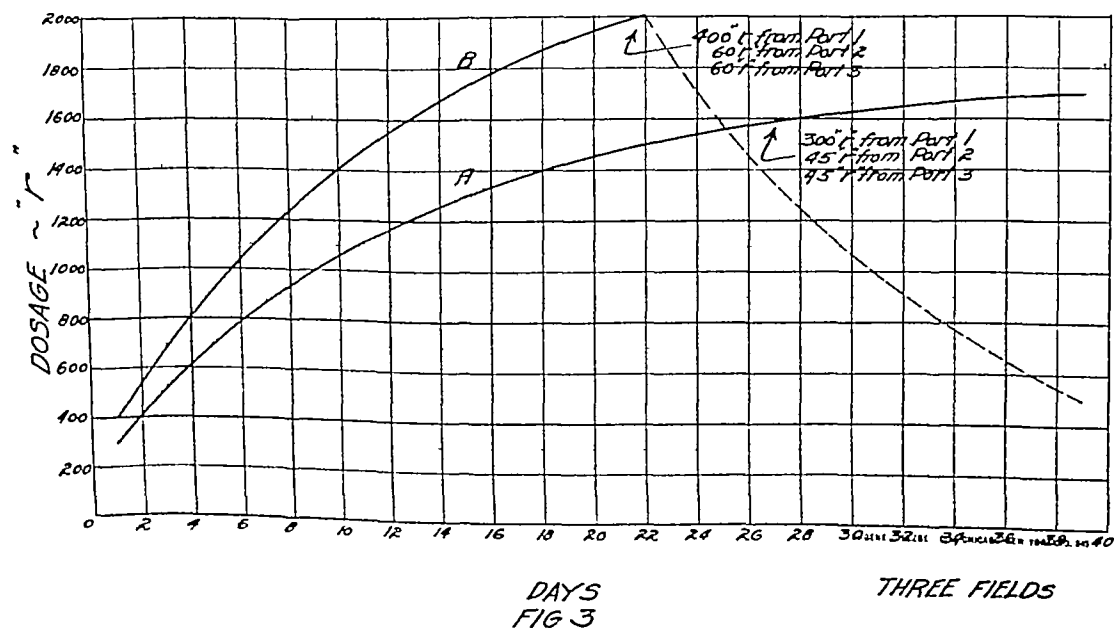
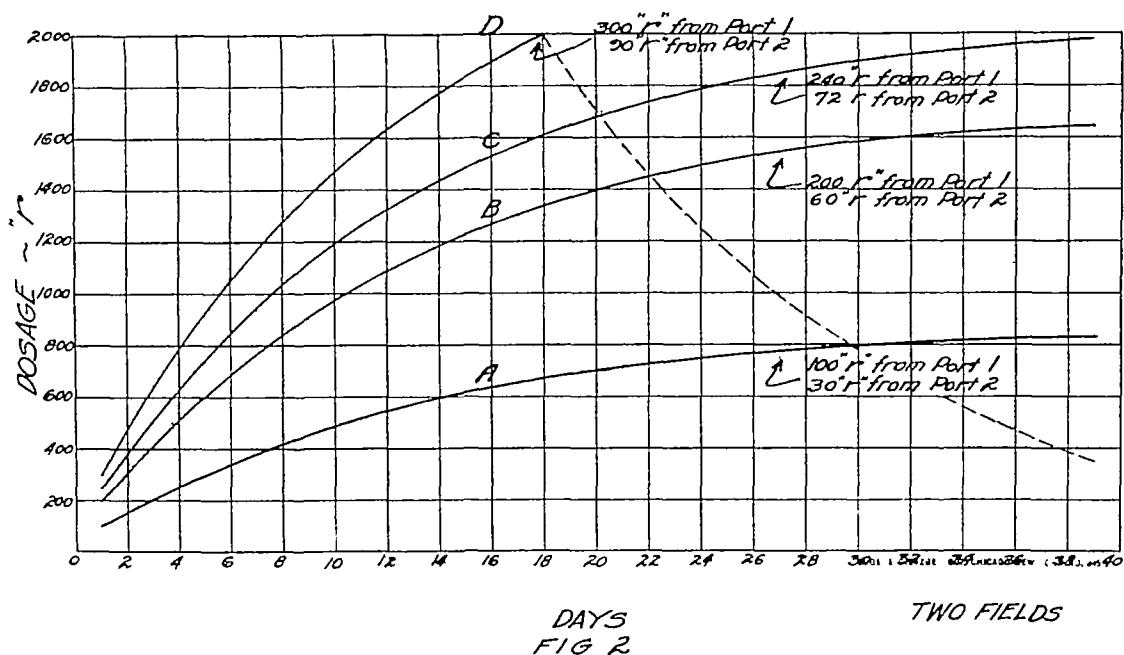
In addition to the loss coefficient varying with wave length, there is also the problem of the variation of dosage with wave length when combining two doses of radiation of different qualities. For example, when radiating a pelvis with an anterior and a posterior port, the anterior skin may receive a total dose of 2,000 r of effective wave length 0.16 Å and in addition, from the posterior port, a total dose of 400 r, which by virtue of the Compton effect may have an effective wave length of 0.24 Å. In order to simplify the calculations, we are forced to disregard this variation in dosage with wave length, and have combined the two values as one dose. In disregarding this variation the error introduced will tend to balance that mentioned in the preceding paragraph.

The cumulative doses as presented in this paper are, therefore, subject to these criticisms and represent approximate values. The purpose of the calculations is to emphasize the possibilities of arriving at conditions of equilibrium by varying the increment, and to point out the relation between the total and the cumulative dose, rather than to give specific information as to definite dosage. The two depth intensities mentioned earlier have arbitrarily been selected as 15 per cent, to represent a typical depth dose with large diameters, and 30 per cent, to represent a typical depth dose with small diameters.

Calculations of the cumulative dose have been made using various increments with both depth intensities and a loss coefficient of 0.08 per day. The results of these calculations when two fields are used are shown in Figure 1, in which the increments are 100 r, 200 r, 240 r, and 300 r, with a depth intensity of 15 per cent, and in Figure 2, in which the same increments are used with a depth intensity of 30 per cent. For the sake of clearness and brevity, only the cumulative dosage values immediately following the treat-

ments to the first portal are plotted on these graphs. The broken line of Curve A in Figure 1 shows the increment added

the radiation applied to the second port, with the accompanying loss within the next 24 hours, followed by the addition of



on one day to Port I, the accompanying loss within the next 24 hours, the small addition to the skin of the first port from

the full increment to Port I, etc. In this case the first port received alternately 100 r and on the following day 15 r from the

second port. The daily depreciation is shown by the downward slope and the amount added by the perpendicular line

CHART I—TWO FIELDS RADIATED, ALTERNATING DAILY

	Dose Total	Increment Cumulative	Total days	Status
Direct	2,000 r			
*15%	300 r			
Total	2 300 r	740 r	100 r	40 equilibrium
Direct	2 000 r			
*30%	600 r			
Total	2 600 r	840 r	100 r	40 equilibrium
Direct	4,000 r			
*15%	600 r			
Total	4 600 r	1,450 r	200 r	40 equilibrium
Direct	4,000 r			
*30%	1,200 r			
Total	5,200 r	1 650 r	200 r	40 equilibrium
Direct	3,800 r			
*15%	702 r			
Total	4 602 r	2,010 r	300 r	25 peak
Direct	2,700 r			
*30%	810 r			
Total	3,510 r	2,000 r	300 r	18 peak
Direct	4 800 r			
*15%	720 r			
Total	5 520 r	1,780 r	240 r	40 equilibrium
Direct	4 800 r			
*30%	1,440 r			
Total	6,240 r	2 000 r	240 r	40 equilibrium
THREE FIELDS ROTATED DAILY				
Direct	4,200 r			
*15%	585 r			
*15%	585 r			
Total	5 370 r	1,700 r	300 r	40 equilibrium
Direct	3,600 r			
*30%	990 r			
*30%	990 r			
Total	5 580 r	2 020 r	300 r	34 peak
Direct	3 200 r			
*15%	420 r			
*15%	420 r			
Total	4 040 r	2 000 r	400 r	22 peak
Direct	2,280 r**			
*30%	600 r			
*30%	600 r			
Total	3,480 r	2,000 r	400 r	16 peak

* Radiation received by the skin of the first port from the increment applied to the other port or ports

** The increment on the sixteenth day was reduced from 400 r to 280 r in order to avoid a cumulative dose exceeding 2 000 r

It is evident from the curves in Figures 1 and 2 that increments of 240 r or less, when applied to two fields alternating daily with the depth intensities shown, produce a condition of equilibrium at dosage levels less than 2,000 r. Were these increments to be used at greater time intervals or should there be skips due to

Sundays and holidays, the level of equilibrium would be considerably lower

As shown by Curves D in Figures 1 and 2, increments of 300 r reach a peak value of 2,000 r in 25 days with a transmitted intensity of 15 per cent, while with a transmitted intensity of 30 per cent from the second portal, a peak is attained in 18 days. The dotted lines of Curves D in Figures 1 and 2, and Curve B in Figure 3 show the loss from day to day following the attainment of the peak condition. A similar loss, of course, follows conditions of equilibrium when the treatments end. Obviously, larger increments would reach this peak in a shorter time.

From the preceding discussion as well as from the information published in the previous paper, it is evident that when the time interval is increased the increment should be increased in order to obtain a peak value, otherwise the cumulative dose reaches a condition of equilibrium at a low level. This is particularly significant when three or more ports of entry are used, and the treatments are rotated so that each field is radiated every third day, as is frequently done in therapeutic practice. Assuming that a field is radiated with a dose of 100 per cent, and that the depth intensity at this point is 30 per cent from the two other ports (15 per cent from each), the calculations of the cumulative dose with 300 r and also with 400 r per field per day are shown graphically in Figure 3. The cumulative dosage curve for the 300 r increment (Figure 3, Curve A) reaches a level of equilibrium at about 1,700 r, whereas the curve for the 400 r increment (Figure 3, Curve B) reaches a peak of 2,000 r on the twenty-second day. Dosage increments less than 300 r, given in this manner, would, of course, build up to a lower level of equilibrium.

When four or more portals are used and the treatments are rotated daily so that each port is radiated every fourth day, the loss of radiation effect from any one of the fields is considerable before that field is again radiated. Therefore, in order to build up the dosage to a 1,700 r

level of equilibrium or a peak of 2,000 r, it is necessary to use larger increments. For example, a dose of 400 r every fourth day, with 15 per cent, or 60 r, being contributed from each of the other three fields on each of the intervening days, would result in a condition of equilibrium at a cumulative dosage level of 1,950 r on or about the fortieth day, whereas a dose of 500 r every fourth day with 15 per cent being contributed from the other three fields on the intervening days, would result in a peak of 2,000 r after only three weeks.

A comparison of the total dose with the cumulative dose for the various increments and depth intensities mentioned is given in Chart I. This comparison emphasizes

the fact that the mere statement of the total dose gives no clue to the cumulative or, as it is sometimes called, the effective dose.

The total amount of radiation compared with the cumulative values as calculated, for the following conditions, is given in chart form.

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THE CLINICAL SIGNIFICANCE OF PNEUMOPERITONEUM¹

By LEWIS J. FRIEDMAN, M.D., *New York City*

Director of Roentgen-ray Department, Bellevue Hospital

THE clinical significance of pneumoperitoneum varies with the mode of entry of a gas into the peritoneal cavity. The presence of a gas in the abdominal cavity can be demonstrated fluoroscopically



Fig 1 A case of ruptured duodenal ulcer. The arrows point to the presence of air in the subphrenic spaces



Fig 2 The arrows point to the almost complete obscuration of the subphrenic space on the right by an abscess which has extended into the thorax

cally and radiographically, therein lying its importance clinically. Roentgenologically, the presence of a gas intra-abdominally is recognized by a dark semilunar shadow in the subphrenic spaces. Although no definite determination has been made as to the smallest amount of a gas that will cast a

shadow, it is believed that as little as 50 c.c. may be visualized on an x-ray film.

Pneumoperitoneum may occur spontaneously or it may be induced for diagnostic purposes. It is also employed as a therapeutic measure in tuberculous peritonitis.

Spontaneous pneumoperitoneum is produced when rupture of a hollow viscus occurs. Lesions predisposing to this accident are as follows: gastric or duodenal ulcer, ileal ulcer complicating typhoid fever, rupture of the urinary bladder, and perforating abdominal wounds.

Cortle and Spalding (1) found the roentgen-ray demonstration of pneumoperitoneum in a perforated ulcer to be of more value than the search for diminished liver dullness. Other observers (2) report the presence of air in the subphrenic space in from 50 to 85.7 per cent of bona fide perforated ulcers. In the few cases the author has observed, all revealed a pneumoperitoneum. In rupture of the urinary bladder, the introduction of air through the urethra resulted in its accumulation in the subphrenic spaces.

Induced Pneumoperitoneum—Occasionally, air is introduced into the peritoneal cavity during an attempted pneumothorax. For diagnostic purposes, it is usually injected transabdominally, in the female the abdominal cavity may also be filled with air by transuterine insufflation.

While it is true that the use of pneumoperitoneum for diagnostic purposes has been developed into a practical and safe procedure, its employment has been relegated to the past several times, since its original description by Kelling, in 1902, and Stewart and Stein (3) in 1919. It is frequently forgotten to-day in the maze of diagnostic methods. To Sante (4), of St. Louis, much credit is due for reducing the rather intricate methods of older investigators to a technique which is of value for its sheer simplicity.

¹ Accepted for publication April 30, 1934.



Fig 3 The arrow in this photograph points to induration of the abdominal soft tissues at the site of a liver abscess. Note the absence of air between the visceral and parietal peritoneum.



Fig 4 A case of carcinoma of the liver. The irregularity in contour of an enlarged liver and fixation is apparent.

Induced pneumoperitoneum for diagnostic purpose is a comparatively innocuous procedure and the indications for its performance may be briefly outlined as follows:

- 1 To differentiate basal intrathoracic pathology from subphrenic disease. A subphrenic abscess will prevent the accumulation of air in the subdiaphragmatic space.

- 2 To study the liver outline. A liver abscess, if superficial and "pointing," will



Fig 5 In the absence of a hemidiaphragm, the production of pneumoperitoneum also causes a pneumothorax. The resulting pneumothorax and the collapsed lung can be seen above the coils of intestines. Film reproduced here was taken in the right lateral decubitus position.

be clearly visualized especially if the surface of the liver is adherent to the parietal peritoneum. This phenomenon can be clearly seen on films taken in the lateral decubitus and supine positions.

- 3 To determine the relation of a mass in the left upper quadrant to the spleen.

- 4 To differentiate eventration from herniation or absence of a leaf of the diaphragm.

- 5 To demonstrate and study the relative position of a retroperitoneal neoplasm to normal structures.

- 6 To study the uterus and adnexa for semi-pedunculated sub-serous tumors, ovarian neoplasms, or cysts. If a film of the pelvis is taken in a modified Sims' position and loops of intestine are retained, the presence of adhesions can be presumed.

The contra-indications for diagnostic pneumoperitoneum vary with the method of introduction of the air.

- 1 The contra-indications in the transperitoneal method are as follows: (a) enormous ascites, (b) extreme obesity, (c) acute peritonitis, (d) repeated laparotomies, and (e) seriously impaired heart.

- 2 The contra-indications in the transuterine method comprise the following in addition to those mentioned above: (a) pregnancy, (b) menstruation, (c) suppurative processes of the genital tract, and (d) acute adnexal inflammation.

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Preparation of the Patient—It is advisable that an aperient be administered the night before, and a cleansing enema be given within the hour or so preceding the examination. The urinary bladder must be emptied either by voiding or catheterization. It is also advisable that one-sixth gram of morphine sulphate with atropine be administered fifteen minutes before the examination to allay fear and apprehensiveness. The gases employed for this procedure are carbon dioxide, oxygen, or pure air. For all practical purposes, air, in spite of its slow dissipation, is a suitable contrast medium in diagnostic pneumoperitoneum since it causes no disagreeable effects.

Technic—1 Transuterine inflation may be accomplished providing one or both tubes are patent, and it should obviously be performed in married women only. For diagnostic purposes, about 700 c c to one litre may be introduced, or until the liver dullness is obliterated.

2 The transabdominal route. Surgical asepsis must be observed. The lumbar puncture needle with the stylet *in situ* is inserted slowly but persistently at a point one and one-half inches to the left and below the level of the umbilicus until the peritoneum is perforated. At the moment the peritoneum is pierced, the patient usually experiences a sudden sharp pain and the operator will feel as if an empty cavity has been entered. The needle is then connected to a Potaine aspirator.

Auscultation of the abdomen will reveal a loud gurgling sound as the piston is plunged into the barrel of the syringe. The absence of this sound indicates that the needle has not entered the abdominal cavity. When assured that the needle has been properly introduced, about 1,000 c c of air is slowly injected, or until the liver dullness is obliterated.

Radiographs are then taken in the following positions: anteroposterior, right and left lateral decubitus, right and left lateral supine, and sitting. For the study

of the pelvic viscera, particularly in the female, the pelvis is elevated about 28° and the exposures made in the anteroposterior and postero-anterior positions. Usually the patient experiences a sense of fullness within toleration. Should undue discomfort occur, the needle may be re-introduced and the air liberated.

CONCLUSIONS

1 The presence of air intra-abdominally, in other than induced pneumoperitoneum, has an important clinical significance.

2 Pneumoperitoneum naturally has its limitations, and its promiscuous use is inadvisable. As one author aptly cautioned, "Don't do this work for idle curiosity."

3 Pneumoperitoneum and intrauterine instillation of iodized oil, when used conjointly, will yield more diagnostic information, in some cases, than either procedure alone.

4 In the use of this diagnostic procedure, the co-operation between either the surgeon, gynecologist or internist, with the roentgenologist, is imperative.

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The dangers of pneumoperitoneum are extremely few, and although hazards were not encountered by the author, they must be considered. The few casualties that have occurred according to the reference in

2 Puncture of the inferior or superficial epigastric arteries is a possibility, but the simple expedient of removing the cannula and re-inserting it above or below the course of the artery will correct the evil



Fig 6 Copy of radiograph taken in the right lateral decubitus position. Observe the fixation and size of the mass (*m*) which is anterior to the kidney (*k*) (the roentgen rays were directed postero anteriorly)

Fig 7 A radiograph of the same patient as shown in Figure 6 taken in the lateral supine position. The arrow *a* points to the loops of the intestines; the arrow *b* points to the tumor situated in front of the kidney. At operation a large cyst containing a sebaceous material was found at the site reported.

the literature are credited to the early era of experimentation with this diagnostic method. It is reasonable to assume that, with more careful selection of patients, no serious results should be encountered. The following complications, however, must be considered:

1 Embolism, this theoretical possibility of fatality is dismissed from practical consideration by most investigators.

3 Perforation of the bowel. Jacobæns, of Stockholm, who revived this diagnostic procedure in 1910, proved by his experiments on cadavers the inability to puncture the hollow viscera on piercing the abdominal wall.

4 The production of subcutaneous emphysema may result if the needle has not been entirely introduced. However, the accumulated air is rapidly absorbed, and no ill effects are usually experienced.

to the microscope. About 95 per cent of the light is said to be deflected to the side-piece while the rest goes up through the

micro-adjusters ('D' and "D") The light (G) is turned "on" and the change noted. The bulb "carriage" is then adjusted

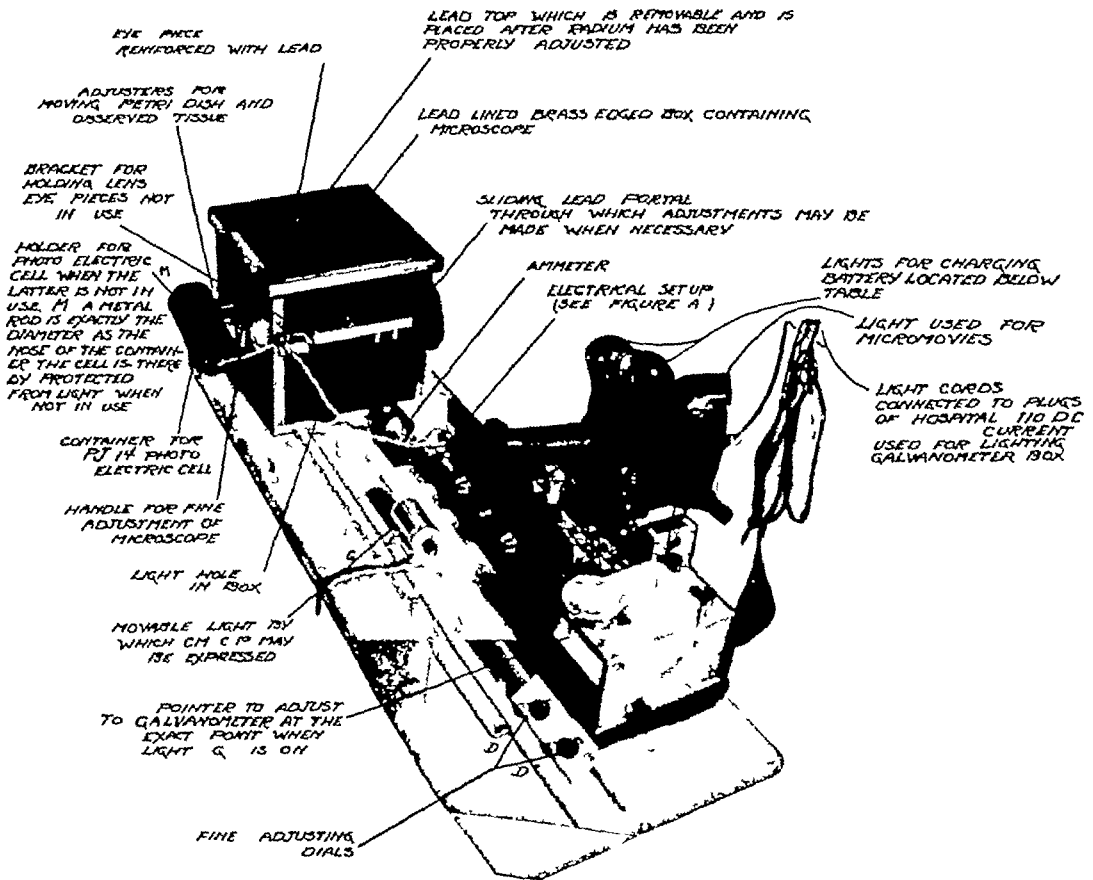


Fig 2 Photograph of apparatus used

usual eye-piece. The container, with a G E photo-electric cell (P E No 14), was attached to the former (Figs 2 and 3).

The string galvanometer (K) is then adjusted so that when the light (G) is "on," the indicator will remain at a certain fixed place on the scale. The light (G) is turned off, and the swing of the indicator noted and marked by the needle (S). Whenever a reading is desired, the indicator is brought to this exact position, shown by the needle (S), by means of the

(either closer or farther away from the object), and the distance required to bring the indicator to the former mark noted. In this way the opacity change of the observed tissue is recorded in centimeter candlepower on the scale (F).

PART TWO

In 1916, Grasmuck noted that radium produced an opacity in microscopically observed tadpole tissue, when it was exposed to adequate radiation. This

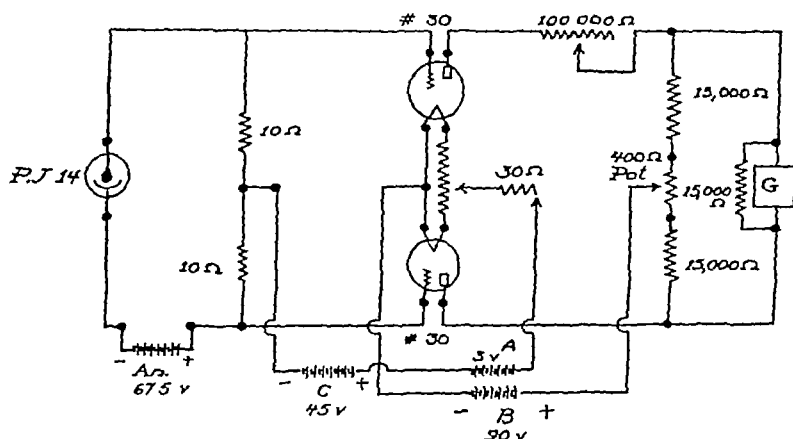
MICRO-NEPHELOMETRY AND ITS APPLICATION TO CERTAIN RADIATED LIVING TISSUES¹

By WILLIAM M MILLAR, M D , Cincinnati, Ohio

From the Department of Surgery of the University of Cincinnati College of Medicine and
the Cincinnati General Hospital

THE purpose of this paper is (1) to present a new instrument of precision for microscopic use, (2) to present certain quantitative data regarding radium exposed tissue obtained by this method

namely, the application of its principles to such laboratory methods. After considerable experimentation, the following electrical set-up as shown in Figure 1 was designed, found suitable, and adapted. Figures 2 and 3 show the method applied



ELECTRICAL DIAGRAM

Fig 1 Electrical diagram of the apparatus used throughout the experiments

PART ONE

The desire for suitable quantitative methods of measurement in microscopic work has repeatedly emphasized itself to biologic workers, and in the measure of opacity or nephelometry has been chiefly dependent upon various dyes and dilutions. But these are cumbersome and impracticable when applied to a living tissue under the high power microscopic lens. The recent spectacular advance of the photo-electric cell in various lines of industrial activity suggested a solution,

to certain radium studies which will be described later on in this paper

Explanation of Figures 2 and 3—The unit of measurement used is a centimeter candlepower. The tissue to be radiated is placed under the microscope (Fig 3). The light (Fig 2), in this instance a single socket 32-candlepower automobile globe, is placed at an arbitrary distance (60 to 70 cm) from the microscope. Suitable lenses are used to make the light beam as nearly parallel as possible, and this is deflected up to the mirror through the tissue to the prism² attached

² The prism is made by the Spencer Lens Company, of Buffalo, N. Y.

It will be concluded by the results plotted in the two lines in Figure 5 that radium causes an increase in tissue opacity

played a very important part and that the greater the rate of blood flow (measured by the number of capillaries in the field

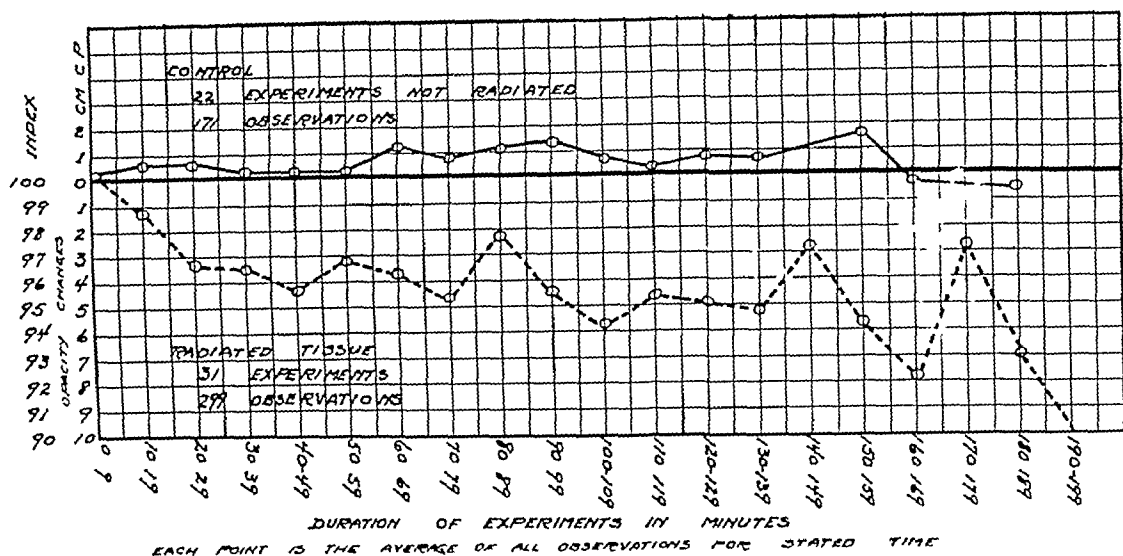


Fig 5 Graph showing (a) Opacity changes in 31 experiments (299 observations), (b) no increase in opacity of the controls—22 experiments with 171 observations

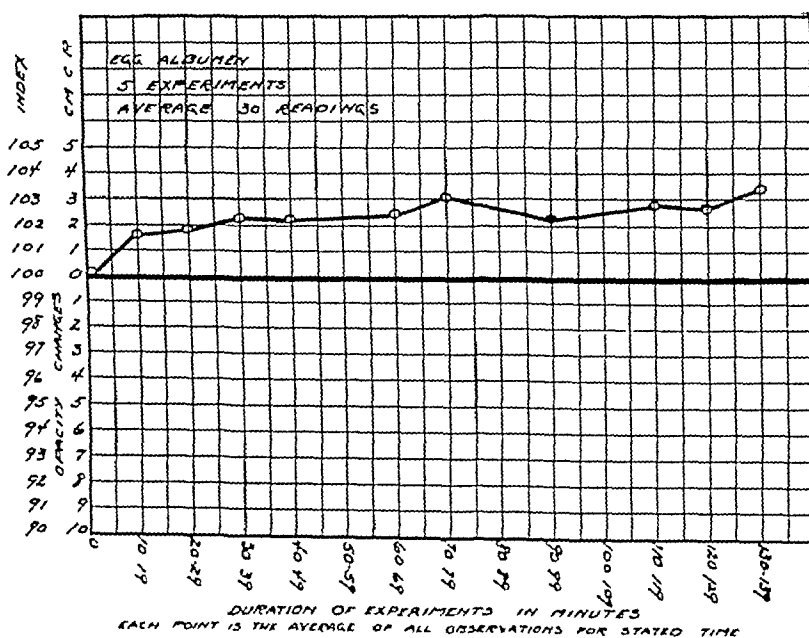


Fig 6 Graph of radiated egg albumen showing no immediate increase in opacity

But what is the reason for this phenomenon? When further studies were completed it appeared that the circulation

and the rapidity of motion of the corpuscles within them) that was present the less rapid and less marked was the

was independently confirmed by us, in 1932. The desire to obtain quantitative data lead to the development of our

Procedure—The tadpole was anesthetized with chlorotone solution,³ placed in a Petri dish, and the high-power micro

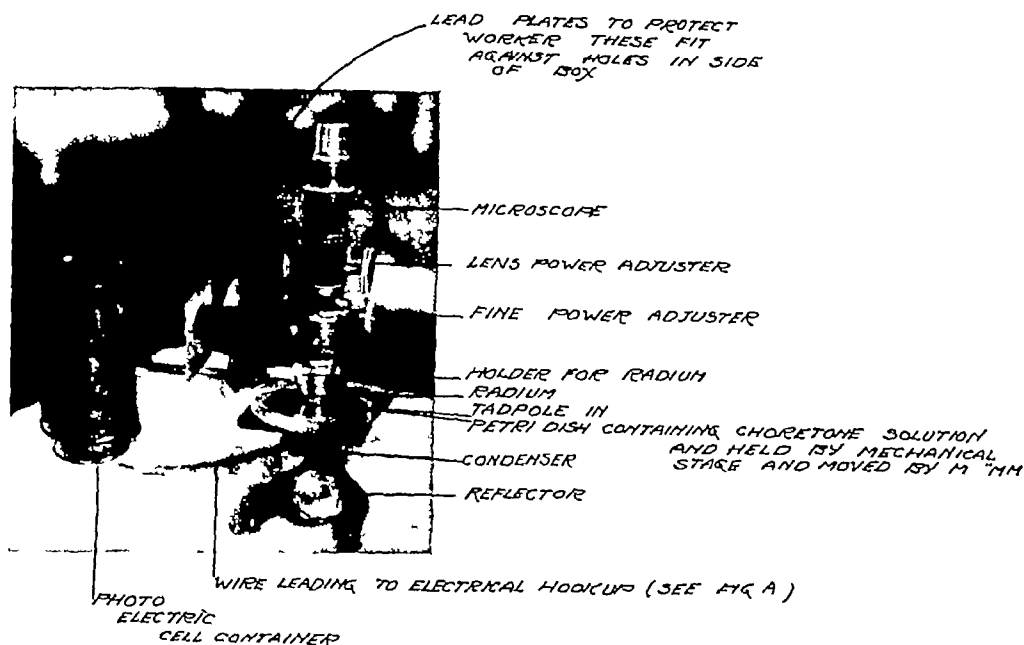


Fig 3 Photograph of microscope showing the attached photo-electric cell

photo-electric nephelometer and its application to further and more complete observations. In a study of the tadpole tail, data were recorded which can best be shown in Figure 5.

scope focused upon it. A constant position was secured by using a small piece of folded lead to fasten the tail and to prevent oscillation. The nephelometer was then used in the manner described above, the readings were taken at given intervals.

Radium—Six needles, each with 12.5 mm of radium placed at their points, were used throughout the experiments. The wall thickness of each needle was stated to be 0.5 centimeter of platinum. They were fastened firmly to the microscope by means of the holder illustrated in Figure 4. The center of this 75 mm "ring" was always kept at the same distance (1 cm.) from the center of the lens or the point of magnification.

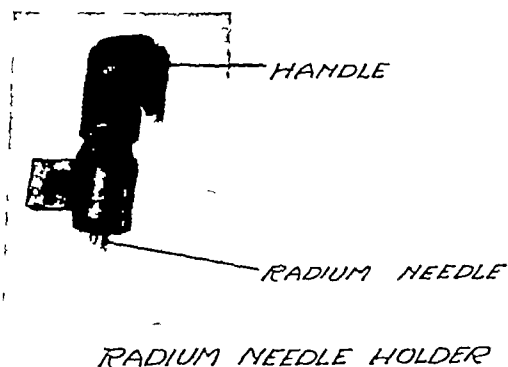


Fig 4 Photograph of radium needle holder which attached to the microscope

³ Other narcotizing solutions were also used to rule out the possibility that the chlorotone alone was responsible for the observed changes.

PYELO-PERISTALSIS CHARACTERISTICALLY ALTERED BY INFECTION, WITH NOTES ON FUNCTIONAL BEHAVIOR OF OTHER HOLLOW VISCERA¹

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WELL co-ordinated function of the various organs of our body is of greater importance to our well-being than perfect anatomic structure. Functional re-adaptation often compensates for irreparable anatomic deficiencies, with which some are or may become afflicted. No thinking roentgenologist will deliberately omit functional investigations. However, we are quite inconsistent in roentgenologic recording and evaluation of function, for instance, very few of us in our routine roentgenologic reports mention the functional status following recovery from bone or joint injuries, although at least some observations of functional ability might be quite easily obtained from either fluoroscopic or radiographic study and could be of value to the attending physician, his patient, or a court. We usually find included in gastro-intestinal reports remarks on the type and behavior of gastric peristalsis, stressing at times the fact that abnormal behavior drew attention to an anatomic lesion, but when the colon is concerned, we very frequently are led to regard temporary functional configuration as pathologic anatomy (colitis), and hardly ever make an effort to obtain information concerning true colonic activity. Six-, 24-, and 48-hour observations are poorly evaluated and are more and more regarded as a useless waste of time and effort. Functional changes after administration of a barium enema are hardly ever studied, yet the problem of constipation alone would warrant more careful analysis, although such might be quite time-consuming. What percentage of chest examinations includes correct notes on the function of all demonstrable intrathoracic structures? How frequently is

the marked elasticity of the infantile mediastinum misinterpreted as evidence of thymic disease? The physiology of the urinary passages is very rarely studied by roentgenologic methods, etc.

Since the advent of excretion pyelography, we are facing new problems of function, of which we were less conscious during times of exclusive retrograde urography. Figure 1A, which shows 18 different images of the same renal pelvis, was obtained by serial-excretion pyelography during 30 seconds. Undoubtedly, pronounced variations in the pyelographic appearance of renal pelvises similar to these shown are observed by many roentgenologists and urologists. What is their significance? Which of these 18 images represents the normal configuration of this renal pelvis? Can one rely for correct interpretation on a few single pyelograms obtained at random following the intravenous injection of the opaque medium? To what extent may "blunting" of calices be regarded a reliable sign of infection?

When attempting an interpretation of this variable appearance of the renal pelvis during excretion pyelography, we must take into consideration the existence of considerable muscle tissue in the urinary transportation tracts, which is well known since J. Henle's publication, in 1866, in the "Handbuch der Systematischen Anatomie des Menschen." He describes in detail the renal anatomy, including the muscle coat of the pelvic mucosa and the "sphincter papillæ." He also indicates that this muscle mass should have a definite function. His painstaking, classical observations still must be regarded as correct, though a few authors have added minor details. J. Disse, in 1902, re-investigated the muscular elements of the renal pelvis and described strands of longitudinal

¹ Presented before the American Congress of Radiology, at Chicago, Sept. 25-30, 1933.

amount of opacity produced. Apparently, the opposite condition was also equally true. In a field in which the observer's eye could not note capillaries or moving cells, the change would proceed with fair rapidity, and about one and a half to two hours were necessary to cause complete opaqueness. This gradual spread of opacity can best be compared by the increasing shadow of the sun during an eclipse. It also would seem that, if the degree of radiation was not too greatly prolonged, a partly reversible reaction would occur. In other words, there would be some diminution of clouding after the radium was removed. The suggestion was made that the change of density might be due to a protein coagulation and that, in order to prove or disprove this, a semi-lucid medium which contained this constituent should be taken and tested in a similar manner. This was done. At first, the ordinary bacteriologic dextrose-acetone agar was used, and no clouding was noted. But the just criticism was made that this did not contain a sufficient amount of protein, so pure egg albumen was substituted. The re-

sults are shown in Figure 6, where it is readily seen from the plotted curve that no coagulation of material (with its resulting opacity) occurred.

CONCLUSIONS

1 A new quantitative instrument for microscopic study is described.

2 Its application to radium-exposed tissue showed the following: (a) That radium, in tadpole tissue exposed to it, gave a demonstrable change in opacity which could be measured in centimeter candlepower units, (b) from certain data obtained, it would seem that this change was dependent upon the circulation present in the observed field.

The author wishes to thank Dr. J. L. Ransohoff for the generous use of his radium, J. L. Ross for his valuable electrical and technical aid, Jacob Link for the construction of the lead box used in these experiments, and Miss Mary Maciel for her photographs and graphs.

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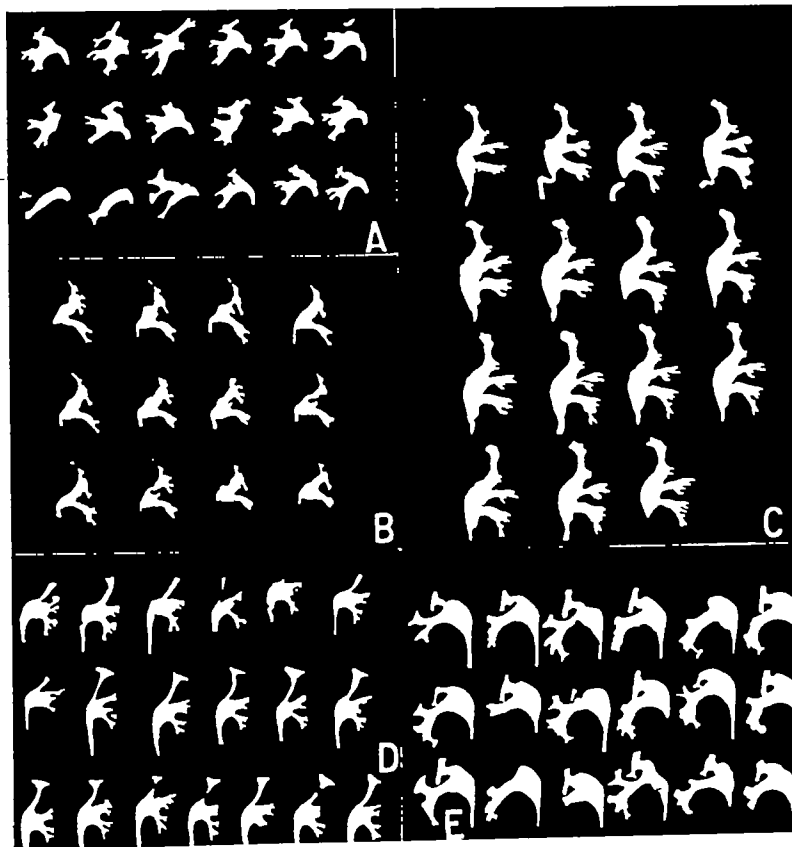
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published observations on nervous elements in the renal pelvis. He found no nerve cells in the renal calices, while an abundance of vegetative sheathless nervous fibers could be observed, which, with their terminations, were found to approach the muscle fibers. He suspected nerve cells in the renal pelvis proper. The presence of these nervous elements in the calical and pelvic mucosa was considered responsible for the automatic tonus of the urinary passages and its adaptation to changing conditions, it was also considered related to the development of neuro-muscular diseases, like atony and hydronephrosis, without obstruction of the passage. I am informed that, at the University of Pennsylvania, a re-investigation of the muscular and nervous elements of the urinary passages has been recently conducted by Dr. Kam under the direction of Professor Batson. The results of this investigation, however, are not published as yet, although from personal communication of Dr. Batson it is learned that no important new structures were found.

Such a well-organized system of muscular tissue in the urinary passages must have the distinct function of contraction and relaxation, which is characteristic of muscle fibers. However, when one scans the text-books of physiology in regard to renal function, very little is to be learned about the renal pelvis, though the ureter is dealt with somewhat more generously. The classical work of Engelmann, published seventy-five years ago and frequently cited since, and papers of Sokoloff and Luchsinger, Lucas, Satani, Wislocki and O'Connor, Graves and Davidoff, Hryntschak, Gruber, Trattner, and others, all contain extensive and important information concerning the ureter under various experimental conditions, but the renal pelvis is entirely overlooked. Penfield states in a report concerning ureteral contractions, that the renal pelvis normally is the pacemaker for the transport of urine to the bladder, but that under abnormal conditions a new pacemaker may be established somewhere else in the

tract. Text-books of urology mention renal and ureteral peristalsis in very short paragraphs, stating that this action and spasm may at times lead to misinterpretation of pyelograms. A detailed analysis of the phenomenon, however, does not seem to exist.

It is surprising that in the literature as recently as 1931 a well co-ordinated function of all these muscular elements of the urinary passages was doubted and denied by certain authors. We found in the proceedings of the Viennese Society of Roentgenology that on June 2, 1931, K. Hutter stated "Transportation of urine in the upper two-thirds of the urinary tract proceeds continually without distinct waves of contractions," and "various degrees of filling of the renal pelvis are caused by various degrees of diuresis rather than by peristaltic action." This statement was immediately opposed by Hryntschak, who undoubtedly knew renal and ureteral peristalsis quite well from personal experience. The first information concerning observed peristalsis of the renal pelvis was recorded by Wassink, who described observation of rhythmic peristaltic contractions of a surgically removed hydro-nephrotic renal pelvis, which persisted for quite a while following the extirpation. Haebler, in 1922, described the differences in the muscular elements of the renal pelvis in man and various mammals, and mentioned that he has repeatedly seen peristalsis of the renal pelvis and calices in man and animals. Westenhoefer, in 1922, reiterated his statement of 1914, remarking also that he personally informed Haebler and his teacher, Professor Ringleb, one year prior to Wassink's publication, about his conceptions of renal peristalsis. All observations of renal peristalsis recorded so far were obtained by inspection of surgically prepared specimens. Legueu, his co-workers, and followers advanced and to a certain degree systematized information concerning this function of the muscular elements by fluoroscopic study of the urinary passages, following the introduction of contrast



Case 4 (Fig 1-D) Miss F E L *History* Traumatic transverse myelitis. Paralysis of bladder treated by permanent retention catheter. Previous cystitis healed. Normal renal function and blood chemistry. *Duration* Four years since spinal fracture. *Organisms* None. *Roentgen diagnosis* Normal. No trace complete contractions of various segments and refilling from periphery.

Case 5 (Fig 1-E) Mr B R E *History* No disease of this kidney demonstrated. Opposite kidney removed two weeks before—gonorrhoeic pyonephrosis. *Roentgen diagnosis* No anatomic pathology. Increased capacity and alternating quite active peristalsis are probably result of increased load before complete compensation.

Case 1 (Fig 1-A) Miss F E R *History* See Series 1-D. *Roentgen diagnosis* Normal. Very pronounced activity. No two images are alike. Which single image represents the normal? Note occasional 'blunting' of calices.

Case 2 (Fig 1-B) Mrs T E L *History* During recovery from acute pyelonephritis. *Duration* Six weeks. *Organisms* *Escherichia (B. Coli)*. *Roentgen diagnosis* No anatomic pathology. Functionally—failure of complete calyceal contractions—residual evidence of infection. Note the three cycles of peristaltic waves in the upper infundibulum.

Case 3 (Fig 1-C) Mrs B, L I *History* Chronic pyelonephritis on opposite side. This kidney not demonstrably infected. *Roentgen diagnosis* Anatomy normal. Alternating weak peristalsis—chiefly middle calyx, pelvis and ureteral bulb. Probably some of the inhibition is due to instrumentation.

Explanation of abbreviations: Pyclography, E—Excretion, I—Instrumental, R—Right, L—Left.

muscle fibers between the sphincter papillae of Henle, and the fornix calicis, which have connections to the renal capsule. He expressed the opinion that these muscle fibers must have the ability to approximate the sphincter to the fornix. Furthermore, he noted regularly a relatively strong band of circular muscle fibers at the junction of calices and renal pelvis. He believed that these muscle fibers may be sufficiently strong to completely occlude and separate the calices from the pelvis.

proper. Westenhoefer, in 1914, stated that intraglomerular pressure alone was insufficient to transport urine from the glomerulus through all tubules into the renal pelvis. He assumed that the muscular elements in the calical mucosa act like a pressure and suction pump, aiding in the transportation of urine through the renal parenchyma and the renal pelvis with its various recesses. He knew the physiologic narrowings of the renal calices, the pelvis, and ureters. Haebler in 1922,

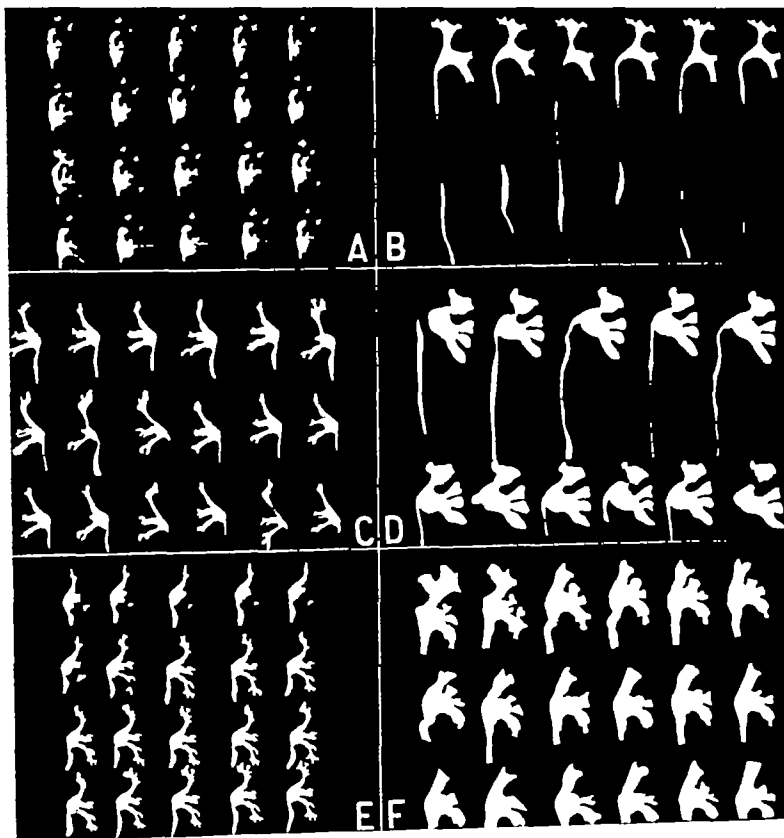
studies and distinguish them from the work of the aforementioned observers (1) We employ the serial-roentgenographic method in contrast to the fluoroscopic, (2) We use chiefly excretion pyelography with various media. Some instrumental pyelographic records were included, principally to illustrate differences from excretion pyelography.

A correct conception of existing renal lumina is not always gained from pyelographic images. Factors inherent to roentgenography of necessity introduce the following conditions which must be borne in mind if misconceptions are to be avoided: unidirectional projection, distortion, rotation, overlapping, lack of sharpness, etc. The information presented must always be regarded as relative in view of perpetual changes to which all living organs are subject. For instance, the factors of fluctuating body hydration and diuresis must be responsible for marked variations.

The illustrations used in connection with this paper were obtained in the following manner: Cine-x-films were carefully traced under a reducing lens with a sharply pointed pencil, they were then printed on photographic paper, silhouettes being cut along the tracing lines which in turn were pasted on cardboard, faces reversed. Some series with delineation insufficient for correct tracing were reproduced photographically and are thus shown. Many series had to be omitted from consideration for technical reasons. The average series consisted of twenty individual pyelograms. Exposure times varied from one-half to one and one-half seconds, intervals averaging one-half to three-fourths seconds. A revolving Åkerlund diaphragm was employed routinely. Records were obtained with respiration arrested in various phases, usually, it was possible to secure from five to eight successive pyelograms without interruption for breathing.

A brief critical review of conditions incidental to the usual type of pyeloscopy or instrumental pyelography and prevailing with serial excretion pyelography as here

presented, is necessary in order to form a proper basis for the interpretation of our studies. For pyeloscopy purposes, as advocated by Legueu and his followers and for the usual instrumental pyelography, cystoscopy with introduction of ureteral catheters is necessary. One can hardly consider such instrumentation as physiologic, and the distress elicited gives sufficient evidence of the defense mechanism invoked. Eliminative efforts of the muscular elements of the urinary passages, stimulated to expulsive action against the foreign body which acts as a mechanical block, must be very strong in some instances, as even the relatively rigid ureteral catheters at times are transported distally over appreciable distances. In addition, the hypertensive solution which is injected into the urinary lumina, not only distends them beyond their normal or accustomed degree but undoubtedly also evokes a strong osmosis, depending in degree upon the concentration of the injected water soluble substance. Under such conditions one can hardly expect normal motor phenomena, and we trust that we can show you later on characteristic behavior of the renal passages, which we regard as the direct result of these procedures. Realizing these factors, which undoubtedly must influence the functional behavior of the muscular elements, we are basing this study chiefly on excretion pyelography. Various contrast media have been used as pyelognost, skiodan and different uroselectan preparations. Characteristically different effects of these preparations on the motor phenomena in the urinary tracts were not observed, but the newer preparations are better tolerated and produce better images. At present, we prefer neo-iopax and neo-skiodan. With these contrast media administered intravenously, we obtain our serial pyelograms, entirely avoiding instrumental or chemical interference with the urinary lumina. The only possible relatively unphysiologic effect might be the increased diuresis resulting from the injection of a hypertensive solution. However, this de-



Case 4 (Fig 2 D) Mr St K L I History Chronic osteomyelitis Roentgen diagnosis Chronic, non destructive pyelonephritis

Case 5 (Fig 2 E) Miss F M History See preceding series Condition after clinical recovery from recurrent pyelonephritis Roentgen diagnosis Gradual appearance of renal lumina Persisting upper ureteral stricture Entirely inactive pelvis L

E Feb 24, 1932 five minutes after injection

Case 6 (Fig 2 F) Mr R D L I History Septicemia Bilateral hemorrhagic pyelonephritis and cystitis Death six months after pyelography No autopsy Duration Eighteen months Organisms Escherichia (B Coli) Roentgen diagnosis Chronic non-destructive pyelonephritis and ureteritis

Case 1 (Fig 2 A) Miss F M History During recurrence of acute pyelonephritis Organisms Escherichia (B coli) Roentgen diagnosis Extremely spastic renal pelvis with reduced capacity (edema) Irregular alternating peristalsis R E, Feb 24 1932 (sides reversed)

Case 2 (Fig 2 B) Mr X L I History Acute pyelonephritis Duration A few days Roentgen diagnosis Anatomically normal marked functional inhibition acute infection

Case 3 (Fig 2 C) Miss F M History Acute bilateral pyelonephritis Impacted calculus in right lower ureter Duration One week Escherichia (B Coli) Roentgen diagnosis Upper ureteral stricture Alternating peristalsis of somewhat spastic appearance L E June 18 1931, during recovery (sides reversed)

Explanation of abbreviations Pyelography E—Excretion I—Instrumental, R—Right L—Left

media through ureteral catheters Since his publications, dating back to 1922, various French, German, and American authors attempted to advance our knowledge concerning these functional phenomena It is somewhat difficult to learn from their publications the exact meaning of their observations, and it is quite apparent that the technic employed—fluoroscopy supplemented by a few roentgenograms taken at intervals—is chiefly re-

sponsible for these difficulties Most of these authors based their studies on the work and conclusions of Legueu, Fey, and Truchot, and no important observation has been recorded beyond those stated by these French authors in their book "La Pyeloscopie," published in 1927 With the analysis of our own observations we will have to refer to these important and valuable French publications Two principal features characterize our own

studies and distinguish them from the work of the aforementioned observers

- (1) We employ the serial-roentgenographic method in contrast to the fluoroscopic,
- (2) We use chiefly excretion pyelography with various media

Some instrumental pyelographic records were included, principally to illustrate differences from excretion pyelography

A correct conception of existing renal lumina is not always gained from pyelographic images. Factors inherent to roentgenography of necessity introduce the following conditions which must be borne in mind if misconceptions are to be avoided: unidirectional projection, distortion, rotation, overlapping, lack of sharpness, etc. The information presented must always be regarded as relative in view of perpetual changes to which all living organs are subject. For instance, the factors of fluctuating body hydration and diuresis must be responsible for marked variations.

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gree of diuresis should not exceed physiologic limits and certainly occurs under various other influences (coffee, alcoholic beverages, etc.)

We repeatedly attempted fluoroscopic observations in combination with these excretion pyelographic procedures, but were disappointed quite regularly. The shadows obtained are relatively faint, even in roentgenograms of good quality, and do not lend themselves to proper fluoroscopic study. Therefore, we relied exclusively on the serial pyelographic method. This discourse should not be regarded as indicative of a hostile attitude toward pyeloscopy. We highly appreciate the work of Legueu and the efforts of our friends, Dr. H. L. Morris and Dr. Carl Weltman, however, we feel that we advance a little further toward the realization of our mutual ideal, namely, true roentgen cinematography. At present this method is hardly applicable to pyelography, as the high amounts of energy required for individual exposures soon would exceed the tolerance of the patient's tissues; there are, however, possibilities under consideration, which may eliminate these technical objections.

Series 1-B is reproduced now, because it illustrates unusually well the regular peristaltic cycles, which traverse the various renal segments. Particularly observe the upper calyx, infundibulum, and the pelvis proper. You will recognize these peristaltic cycles on review of the twelve successive images reproduced. This type of peristalsis is quite different from that seen during pyeloscopic study after the usual routine. You will remember that Legueu and his followers unanimously describe an alternating type of peristalsis, during which contraction of the calices is accompanied by relaxation and distention of the pelvis, and *vice versa*. Here we have different phenomena. We notice a progressive, descending pro-peristalsis, starting in the periphery and continuing toward the ureter. (We do not regard this series as entirely normal. Clinically, the patient is just recovering from an acute

pyelonephritis with *Escherichia (coli)* cultured from the urine. It is observed that *complete* caliceal contractions do not occur, and that the formation of the ureteral bulb is somewhat indistinct. We consider these signs to be mild residual evidence of the previous infection, but, in view of the otherwise excellent functional behavior, we venture to give the patient a good prognosis for complete recovery.) The beautiful regularity of the peristaltic rhythm is not apparent in all following series, because images were not always timed as ideally as was incidentally obtained here. Illustration 1-C, in contrast, shows the alternating type of peristalsis, which is observed regularly with instrumental serial pyelography or pyeloscopy. Clinically, this patient's kidney had to be regarded as entirely normal. A review of the images reproduced generally shows larger lumina, which during the procedure gradually diminishes in size. Irregular peristaltic waves arise here and there in the renal pelvis, and finally you see alternating contractions, particularly of the middle and lower calices and the pelvis. The ureteral bulb is well formed. Ureteral kinks just below the uretero-pelvic junction seen in some images are merely the result of inspiratory shifting. We hope that the essential differences between these two types of motor phenomena, the normal physiologic, progressive, descending pro-peristalsis and the alternating type of peristalsis, are convincing. The latter, to which we will refer again later on, we believe to be an obstructive type of peristalsis, or it may be termed a disturbance of normal gradients. At times, we have designated it as renal vomiting. Both kidneys illustrated by series 1-D and 1-A are considered clinically normal, though a cystitis was observed at one time. In illustration 1-D, complete caliceal contractions in various segments may be observed and apparent refilling from the periphery. No two, of the eighteen images of illustration 1-A mentioned above, are alike. This renal pelvis undoubtedly was in a state of great activity. The sequence of the

Case 1 (Fig 3 A) Mrs De L, R I *History* Bilateral pyelonephritis cystitis *Duration* Uncertain *Organisms* Not recorded *Roentgen diagnosis* Chronic—partly destructive (?) pyelonephritis ureteritis with strictures Observe complete rigidity of renal pelvis and upper ureteral segment

Case 2 (Fig 3 B) L I *History* Condition after recovery from acute low ureteral obstruction—one week before this study *Duration* About six months *Organisms* Not recorded *Roentgen diagnosis* Over distended, partly extrarenal pelvis Development of powerful alternating peristalsis

Case 3 (Fig 3 C) Mrs S, R I *History* Acute pyelonephritis *Duration* Very short, according to patient *Organisms* *Escherichia (B Coli)* *Roentgen diagnosis* Rather chronic destructive pyelonephritis (Tubercle bacilli not ruled out) Reproduced films 1, 10, and 20 of a series of twenty Ap parent motility is simulated by gradual migration of NaI into recesses of pelvis No peristalsis whatsoever

Case 4 (Fig 3 D) M S, R I *History* Recurrent pyelonephritis ptosis palpable kidney *Duration* Uncertain *Organisms* *Escherichia (B Coli)* *Roentgen diagnosis* Observation during quiet period over distention Overflow emptying with weak ineffective alternating peristalsis

Case 5 (Fig 3 E) Mr T P L I *History* Calculus pyonephrosis *Duration* Uncertain of long standing *Organisms* *Escherichia (B Coli)* *Roentgen diagnosis* Destructive pyonephrosis with calculus Only first and twentieth images of series reproduced as no motion could be detected

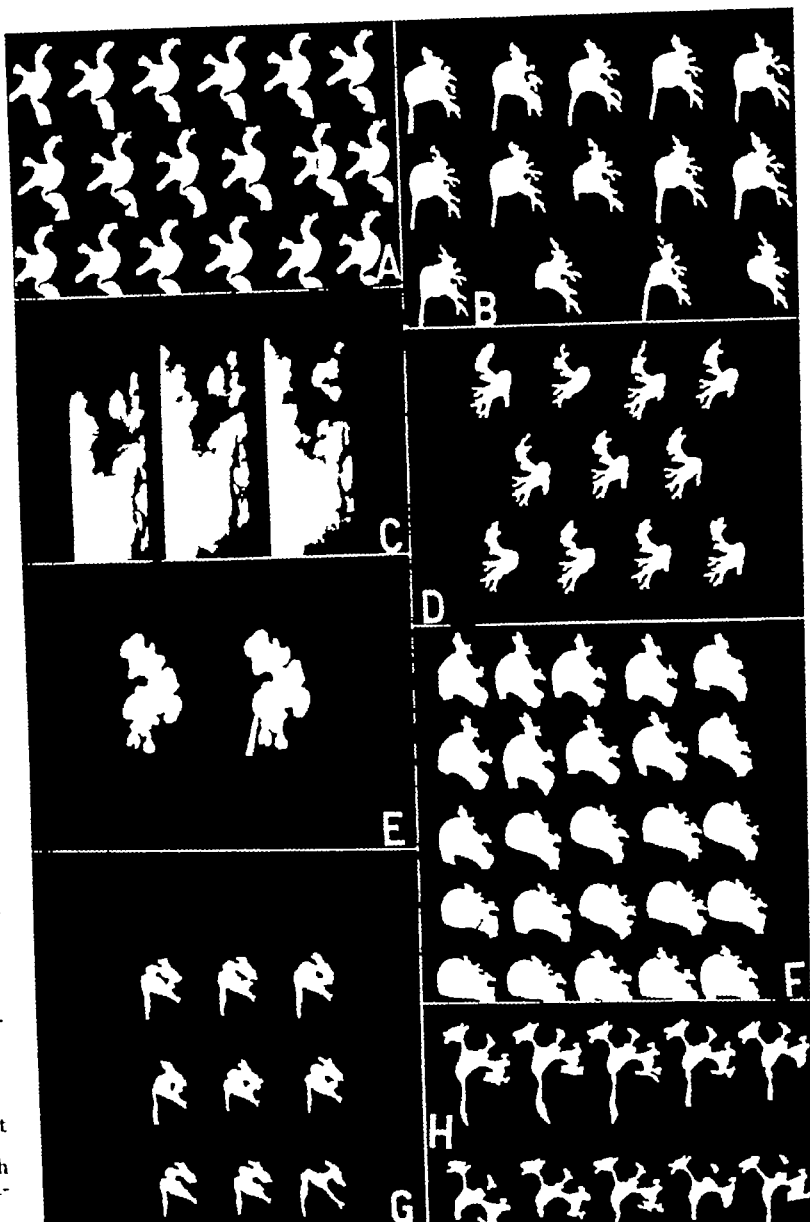
Case 6 (Fig 3 F) Mr I R I *History* Infected hydronephrosis ureteritis cystitis *Duration* Ten years *Organisms* *Escherichia (B Coli)* *Roentgen diagnosis* Chronic

non destructive pyelonephritis Note remaining competency of ureteral sphincter, and activity of minor calices

Case 7 (Fig 3 G) Mrs D *History* Repeated laparotomies during 14 years at various hospitals She had appendicitis adhesions pus in abdomen oophoritis and salpingitis gastric ulcer etc The patient was admitted in October 1929 and in December, 1929 she suffered with acute retention cystitis Urologic examination was negative *Roentgen diagnosis* (Renal

pelvis) mild distention of pelvis and calices, inability at complete segmental contractions good progressive properistalsis state after recovery from acute pyelonephritis of short duration Images show phases of two peristaltic cycles

Case 8 (Fig 3 H) Mr G R R I *History* Mild chronic pyelonephritis under treatment *Duration* From six to eight months *Organisms* *Escherichia (B Coli)* *Roentgen diagnosis* Over distention overflow emptying Very limited activity Cicatrization in the upper infundibulum



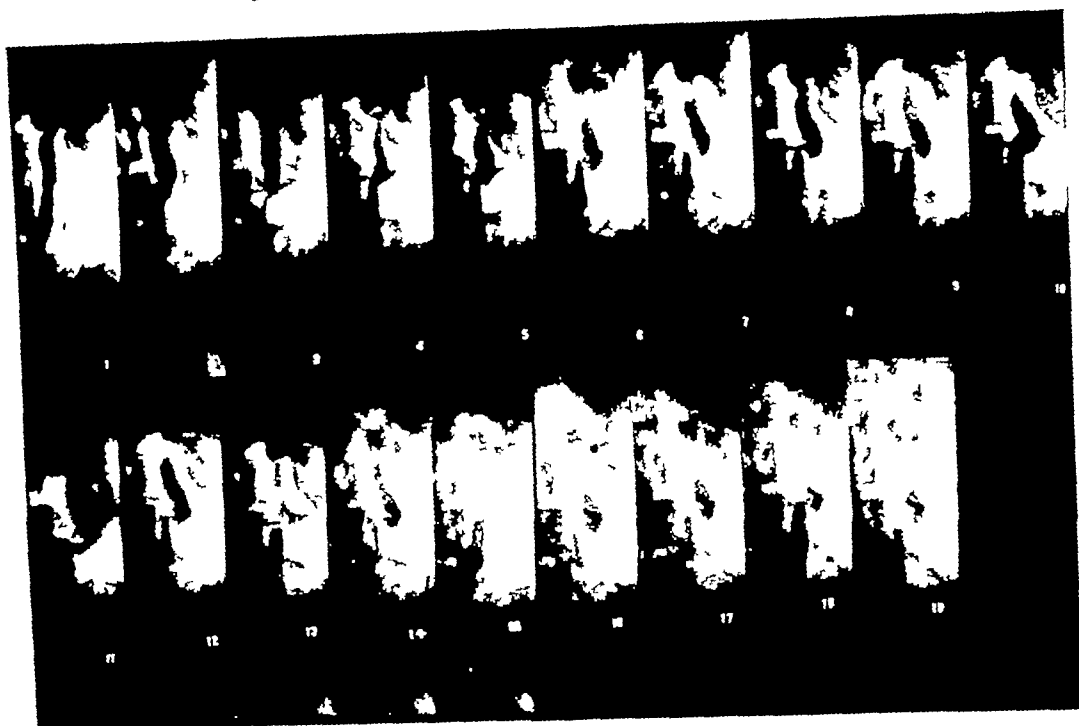
rhythm is not always as well apparent as in Series 1-B, but the type of contractions can be studied quite readily. There is no alternation between calices and pelvis proper. A survey of these eighteen images must bring vividly to our mind the possibilities of mistaken diagnoses, arising from too few pyelographic records taken at random. Every one of these eighteen images, of course, must be regarded as entirely normal, presenting merely various phases of peristaltic cycles, and *temporary blunting* of calices does not signify infection.

Series 1-E shows the first deviation from normal function. Following recent extirpation of the opposite kidney, it may be noted that this kidney is carrying an excess load. The size of the renal lumina and the pronounced activity, showing a tendency toward alternating contractions, are regarded as the results of loss of balance between excretory load and carrying ability, or incomplete adaptation to new conditions. We want to draw particular attention to the fact that complete contractions of various calical segments occur, thus we consider to be an important point for the interpretation of the absence of chronic infection.

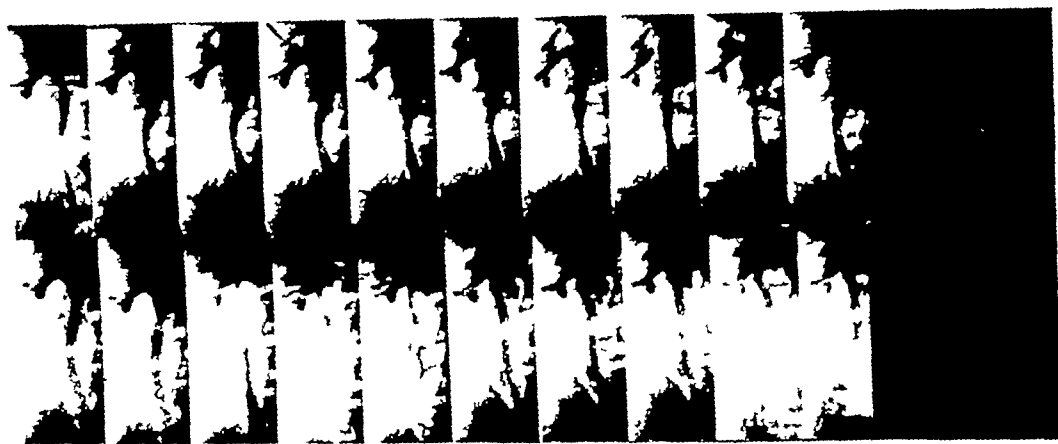
A remark concerning the physiologic content, capacity, and so-called emptying time of the renal pelvis will be justified in this connection. The five series presented show the renal pelvis more or less filled. As seen with excretion pyelograms, it is never entirely empty, but its content and capacity may vary widely under fluctuating intrinsic and extrinsic conditions. Content and capacity are not synonymous terms, the latter depends on the degree of elasticity, the former chiefly on the tonus of the mucosa. The normal renal pelvis undoubtedly can adapt itself quite readily to various conditions of body hydration, diuresis, and a certain impairment of evacuation, as it occurs physiologically with increasing filling of the bladder. Information about factors influencing the pelvic tonus is lacking. "Emptying time" must be considered a logical error and could only be con-

ceived under conditions of instrumental pyelography and pyeloscopy with foreign material introduced artificially. The question is often asked, as to how the renal pelvis fills under normal conditions. We have reason to assume that such filling takes place rhythmically from the periphery, under the influence of the milking action of the so-called calical sphincters, which seem to have a stripping effect upon the pyramids. If this conception is correct, the refilling does not consist of a continuous even inflow from all renal segments, but proceeds segmentally from the various calices with their individual contractions. One may speculate that these contractions in turn are elicited by filling and distention of the renal tubules.

At this point it seems worth while to contemplate briefly on the intrinsic mechanism which is responsible for the motor phenomena demonstrated above. We cannot refer to any experimental work in this connection, as we did not find a record of such concerning the renal pelvis. The effect of decapsulation of the kidney on the motor function of the renal pelvis is not known, it might possibly produce alteration similar to that seen in the bowel following the cutting of the vagi and splanchnics, and also degeneration of Auerbach's and Meissner's plexus. The very extensive investigation of the gut, so well reviewed in Alvarez' book, "The Mechanics of the Digestive Tract," must of necessity elicit the thought of analogies, present in the urinary tract. But unfortunately one cannot regard the mystery of intestinal peristalsis as solved in spite of the overwhelming wealth of work. There remain uncertainties, contradictions of observations, interpretations and deductions, and many purely philosophical theories, not based on observation of facts. A few important points, however, should be stressed. Bayliss and Starling's law of the intestine, or the so-called myenteric reflex, cannot be upheld in the light of recent knowledge, though it dominates physiologic text-books. Small-intestinal muscle freed from all nerve plexus will continue



A



B

Case 1 (Fig 4 A) *Pelvic peri ureteritis* with pronounced pro- and anti peristalsis in upper two-thirds of ureter. The pelvic ureteral segment (one third) does not distend to accommodate and pass on amounts of urine brought down from the renal pelvis (sequela to pelvic inflammatory disease)

Case 2 (Fig 4 B) *Pelvic peri ureteritis*. Anti peristalsis of the ureter is less pronounced segmentation less evident but regurgitation into the renal pelvis cannot be denied

to contract under suitable conditions, also cultivated, undoubtedly nerve-free smooth muscle cells will contract rhythmically. Alvarez and Mahoney made the following statement "Consequently there is no need for looking beyond the muscle for the source of the rhythm" and the conception that Auerbach's or Meissner's plexus was the source of intestinal peristalsis has to be abandoned, yet on the

other hand, vagus and sympathetic exert an undeniable controlling influence on intestinal function

Alvarez has formed the conception of gradients of peristalsis and assumes gradients of rhythmicity, irritability, latent period, tone, muscular strength, and metabolic rate. He summarizes his conceptions as follows "If I were asked to formulate a law for the intestine, I would say

that stimulation of any point leads to the holding back of material coming down from above and the hurrying onward of material already below." He also states that factors altering the gradients include traumatization, inflammation, ulceration, and may be localized in (1) the mucous membrane, (2) the muscle lining the tract, (3) the serous coat, (4) the neighboring organs, and (5) possibly in the nervous plexus. He expressed in a private letter his opinion concerning conditions of transportation of urine, as follows: "If I remember correctly [from your exhibit] the waves that go down the ureter begin up in the calices of the kidney. From analogy with conditions in the digestive tract this is just what I would expect."

Anything which will raise the irritability or metabolic rate of the tissues along the tract, even if it does not produce mechanical obstruction, is likely to block or to reverse waves and to produce back pressure and even complete obstruction. I have suggested in one of my papers that the dilated ureter and kidney pelvis so commonly seen in pregnancy, can be due to the same dynamic reversal that we get in the bowel. Nervous stimulation which might tend to raise the irritability of the lower end of the ureter might also produce back pressure."

We have not at our disposal a physiologic laboratory, nor the time and means to conduct detailed, purely physiologic experimentation. From a practical clinical viewpoint, and our own experimentation, we can readily accept Alvarez' conceptions. Their consideration is well worth while in the evaluation of all pyelographic investigations. The alternating type of pyelo-peristalsis, shown above in Figures 1-C and 1-E might well be termed a decided disturbance of peristaltic gradients, if one wants to follow Alvarez' train of thought. We also want to mention in this connection that we have seen a prolonged, temporary inhibition of renal motility as the result of nausea and headaches.

Having thus demonstrated what we be-

lieve to be normal peristalsis of the renal pelvis under physiologic conditions, we now shall attempt to describe and illustrate changes in this mechanism, which take place as a result of infection in various stages. A pyelonephritis in its acute stage is characterized by edema and increasing round cell infiltration. Such pathology is rendered manifest in excretion pyelograms by the apparent persistent discontinuity of the renal lumina (for which perhaps spasticity might also be in part responsible). Figure 2-A demonstrates this point very well, showing also a relative reduction in size of the entire renal pelvis. From this series it is also apparent, that instead of the normal, progressive, descending pro-peristalsis the alternating type of peristalsis as seen with instrumental pyeloscopy and pyelography is present. Undoubtedly there is also an appreciable degree of irritation which is well expressed by the arrhythmic violent mass contraction.

Figures 2-C and 2-E show the opposite kidney of the same patient in somewhat different phases of the infection. In 2-C the renal lumina are relatively small—as the result of edema present. Peristalsis is of the alternating type, arrhythmic and somewhat reduced in force. Most calical contractions are incomplete. There exists an upper ureteral stricture, which is regarded as partly responsible for the change to the alternating type of peristalsis. The same kidney, after clinical recovery from this infection is shown in Series 2-E. The first images reproduced here demonstrate the gradual appearance of opacity in the renal lumina shortly after injection of neo-iopax. The succeeding images show increasing distention but hardly any peristaltic activity—we designated such inactive emptying as overflow emptying. We feel inclined to assume that rather severe damage to the muscular apparatus of this urinary tract developed with the active pyelonephritis.

As edema and round-cell infiltration increase, the musculature is more and more inhibited and a study of its function during an acute pyelonephritis of a few days' dura-

tion shows more or less elimination of peristalsis. This is illustrated in Series 2-B. Each of the six images reproduced appears to be anatomically normal. A review of the series, however, which we could have prolonged at will, shows rather marked paralysis. We consider this interference with the active transportation of urine to be an important factor in the development of hydro- and pyo-nephroses. We believe that this inhibition of peristalsis starts a vicious circle, leading to increasing distention and stasis, increasing round-cell infiltration, pressure atrophy, and finally, destruction of mucosal and parenchymal elements.

Consequently, observation on more or less chronically infected renal pelves will show increasing distention of the lumina and increasing inactivation of the transportation tract on organic basis. With artificial re-establishment of drainage, one may expect to detect cicatrization and sclerosis.

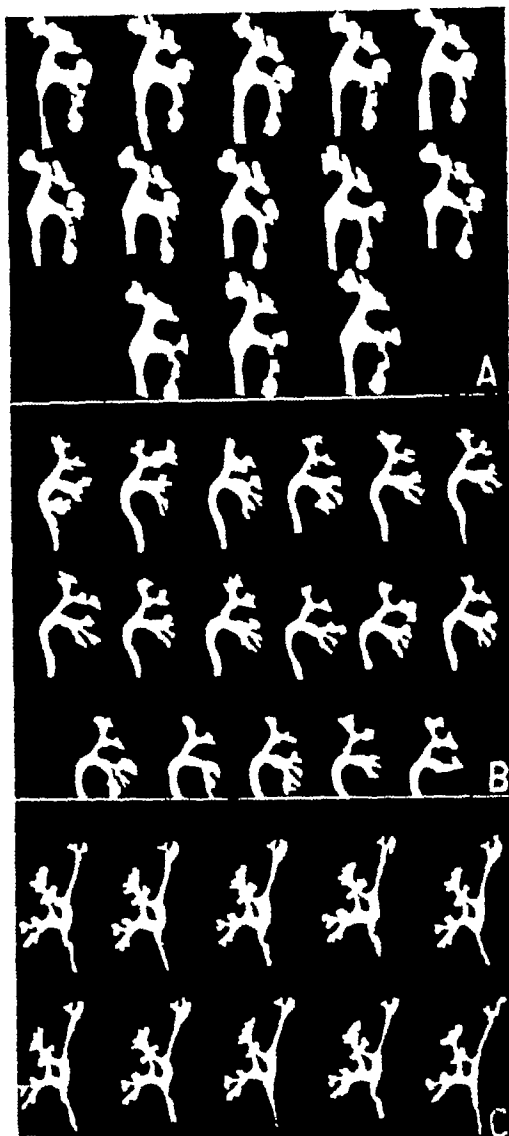
The succeeding illustrations demonstrate anatomic and functional conditions of renal pelves in various stages of infection. Few remarks are necessary in addition to the legends.

Figure 2-D shows a pyelonephritis of somewhat longer duration. Anatomic changes are quite apparent. Concerning the physiologic behavior, we want to point out the inability of the calices to expel their contents completely, furthermore, reversal to the alternating type of peristalsis with rather weak pelvic contractions.

Figure 2-F is a series of instrumental pyelograms, beginning with relative over-distention of the renal pelvis, which is gradually corrected by overflow. Afterward a pronounced immobilization of the renal lumina is quite apparent.

Figure 3-A shows that immobilization in this stage is complete. We feel inclined to assume that the muscle coat of this renal pelvis underwent either destruction or atrophy to an appreciable extent.

Figure 3-C shows a chronic, destructive pyelonephritis, with complete immobili-



Case 1 (Fig 5-A) Mrs Z I L History Essential hematuria Duration Five years Organisms *Escherichia (B Coli)* Roentgen diagnosis Chronic pyelonephritis and ureteritis Stricture in lower infundibulum

Case 2 (Fig 5-B) Mr T S L I History Colitis Chronic pelvic adnexitis—prostate seminal vesicles No renal symptoms Duration Uncertain Organisms *Escherichia (B Coli)* Roentgen diagnosis Capacity reduced (?) Alternating peristalsis Widely patent uretero-pelvic junction Chronic cicatrizing pyelonephritis

Case 3 (Fig 5-C) Mrs S S, R I History Three months after nephropexy for pyelectasis, ptosis chronic non responsive infection Clinically cured Duration Quite chronic Organisms *Escherichia (B Coli)* Roentgen diagnosis Rigid sclerosed renal pelvis

zation of the renal pelvis. Gradual diffusion of contrast medium into various recesses of the pelvis should not be confused

with peristaltic efforts (only three of the twenty records were reproduced)

Figure 3-E shows a pronounced pyonephrosis. No sign of muscular activity is preserved (only two of twenty records were reproduced as no other changes were apparent)

Not all series coming to observation are as readily analyzed and correlated as those presented so far. The severity of a pyelonephritic infection may vary as may also the reaction between the infecting agent and the host. Each subject presents its individual problem and Figures 3-G, 3-D, 3-F, 3-H and 4-A and 4-B demonstrate some of our interpretations with interesting physiologic observations. In addition to the legend, we want to point out that from the functional behavior of the kidneys a prognosis of complete anatomic and functional recovery was given to the patients of Series 3-G and 3-B, while Series 3-D, 3-F, and 3-H suggest various degrees of permanent irreversible damage to the renal pelvis, or its calices, respectively, with sufficient functional ability left to justify conservative management. Series 4-A and 4-B are introduced as examples of low ureteral stricture produced by peri-ureteritis, the effects of this inflammatory process surrounding and probably also invading the lower ureters are principally identical in both cases but different in severity and duration. It should be emphasized that the diseased portions of the ureters are the lowest pelvic segments (not so well included in Series 4-B) which anatomically appear rather normal but are in reality rigid, devoid of elasticity and motility. The upper segments, which are so markedly distended, are to be regarded as functionally competent. The distention and the pronounced peri- and katalstalsis, apparent in the upper segments, represents a compensatory attempt at correction of the deficiencies below. Series 5-A, 5-B, and 5-C are reproduced to illustrate different degrees of cicatrization and sclerosis in the renal pelvis.

Some time ago we attempted to tabulate the roentgen symptomatology of infected

urinary passages for the Chapter on "Renal and Perirenal Infections" by Dr. H. W. Plaggenmeyer in the Cyclopaedia of Medicine (Piersol). This table and four additional ones are reproduced as the shortest possible résumé of our conceptions of pyelonephritis, which is admissible in this paper. We are well aware of the deficiencies of these extremely abstract records.

Finally, it is our desire to mention analogies and characteristic differences in the functional behavior of other hollow viscera. This entails a repetition of statements made in previous publications, which, however, are not yet commonly known and accepted.

Bronchial peristalsis is timed to the expiratory phase of the respiratory cycle, while a relaxation of all bronchial structures takes place during inspiration. No similar coincident timing of renal or intestinal peristalsis is known, but, under normal conditions, bronchial, intestinal, and renal peristalsis are of a rhythmic, progressive, propulsive type, alternating with periods of "diastole."

A relative insufficiency of bronchial musculature was demonstrated in emphysema, apparently as an incompetency of the alveolar sphincters. Such dysfunction distinctly reduces the efficiency of bronchial peristalsis, preventing complete pulmonary ventilation. Certain disabilities of renal pelvises, including some types of mild hydronephroses, may be cited as analogous conditions. Mild intestinal atony can be considered as an equivalent dysfunction.

Analogies between infected bronchiectasis, pyonephrosis, and pyosalpinx require no further explanation, distention of the viscus, infiltration, and destruction of its wall, with resulting immobilization on organic basis, are the characteristic features of such pathology. The analogy to vomiting may be found in the alternating type of renal peristalsis.

In two patients with bronchial asthma, we observed marked local and general spasticity of the bronchi. Similar condi-

JARRE AND CUMMING PYELO-PERISTALSIS

TABLE I—ROENTGEN SYMPTOMATOLOGY OF INFECTED URINARY PASSAGES

Type of infection	Roentgen anatomy of the			Renal Pelvis and Calices			Roentgen physiology			Additional information from excretion pyelography			Recovery
	Renal pelvis and calices	Ureter	Capacity	Peristalsis	Emptying type	Ureteral peristalsis	Appearance time	Concentration	General di-monstrability				
1 Absent	One of the normal variations	Shallow S-curve often with inspiratory double limb	Normal (3-8 c c)	Well-defined rhythmic peristalsis	Active rhythmic	Fast proper status frequently good expulsion bulbs	Short less than 5 min	Good early	Inconsistent with few films at times unsatisfactory	To normal possible with out anatomic or functional deficiencies			
2 Acute General	Not demonstrably altered			Inhibited (paralyzed due to edema and early infectious infiltration)	Inactive overflow	Lagging or spastic expulsion bulb	Short	Good early	Unsatisfactory				
3 Subacute subchronic	Moderately distended	Early dilation	Moderately increased	Weak in efficient	Mixed partly active partly overflow arhythmic	Sluggish no expulsion bulb	Not impaired	Good	Good throughout	Possible functional deficiencies loss of expulsion bulb occasional structure potential by hydronephrosis and stone formation			
4 Chronic non destructive	Marked distention pressure on parenchyma	Dilation	Markedly increased	Absent	Chiefly over flow occasional at attempts at contractions arhythmic	Poorly defined peristaltic contractions	Delayed	Reduced (?)	Fair	Accompanied by creatinin retention, elevated flow emptying, and potentialities of No. 5			
5 Chronic destructive	Excavation of parenchyma	Irregular dilation	Large	Absent	Overflow and by external forces	Absent	Much delayed depending on condition of renal remnant	Often poor result	Poor	Unlikely though renal function and recovery important can be accomplished			
6 Chronic per ureteritis and structure	Degree of distention depending on location of partial obstruction	Involved part narrow dilation above preceding proximally	Increased	Enforced pro and anti peristalsis	Very active	Involved part rigid obstruction type pro and antiperistalsis poor	Short	Good early	Good above obstruction and in bladder	Subjective and objective improvement follow any dilation of obstruction and recovery of infiltrates functional deficiencies will persist in possibly lessened degree			

Remarks

- Effects of acute per ureteritis have not been studied as yet
- From several observations we feel inclined to conclude that neurotrophic disturbances (along parasympathetic) may in some instances produce changes much resembling those incident to infection in various stages
- Effects of primarily localized but from the onset involving and destructive infections—tuberculosis actinomyces etc.—may be locally deduced from the above table according to location extent and duration Often a non specific general infection is found superimposed complicating the interpretation of roentgen studies

with peristaltic efforts (only three of the twenty records were reproduced)

Figure 3-E shows a pronounced pyonephrosis. No sign of muscular activity is preserved (only two of twenty records were reproduced as no other changes were apparent)

Not all series coming to observation are as readily analyzed and correlated as those presented so far. The severity of a pyelonephritic infection may vary as may also the reaction between the infecting agent and the host. Each subject presents its individual problem and Figures 3-G, B, D, F, H and 4-A and 4-B demonstrate some of our interpretations with interesting physiologic observations. In addition to the legend, we want to point out that from the functional behavior of the kidneys a prognosis of complete anatomic and functional recovery was given to the patients of Series 3-G and 3-B, while Series 3-D, 3-F, and 3-H suggest various degrees of permanent irreversible damage to the renal pelvis, or its calices, respectively, with sufficient functional ability left to justify conservative management. Series 4-A and 4-B are introduced as examples of low ureteral stricture produced by peri-ureteritis, the effects of this inflammatory process surrounding and probably also invading the lower ureters are principally identical in both cases but different in severity and duration. It should be emphasized that the diseased portions of the ureters are the lowest pelvic segments (not so well included in Series 4-B) which anatomically appear rather normal but are in reality rigid, devoid of elasticity and motility. The upper segments, which are so markedly distended, are to be regarded as functionally competent. The distention and the pronounced peri- and katalstalsis, apparent in the upper segments, represents a compensatory attempt at correction of the deficiencies below. Series 5-A, 5-B, and 5-C are reproduced to illustrate different degrees of cicatrization and sclerosis in the renal pelvis.

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(6) Analogies in the physiologic behavior of various hollow viscera are briefly pointed out

TABLE IV—PATHOGENIC ORGANISMS (INFECTING AGENTS RESPONSIBLE FOR URINARY TRACT INFECTIONS)

- A Specific strains
Neisseria gonorrhea, *mycobacterium tuberculosis*, *hyphomycetes* (pathogenic moulds), *blastomycete* (pathogenic yeasts), *trichobacteria* (actinomyces etc) *treponema pallidum*
- B Aspecific strains (frequently mixed or possibly admixed to specific strains)
Escherichia (coli) eberthella (typhoid), *salmonella* (paratyphoid) groups
Staphylococcus and *streptococcus* groups
Escherichia group causes 80 per cent of all these infections Recognition of bacterial mutation important

TABLE V—COMMON FACTORS PREDISPOSING TO URINARY TRACT INFECTIONS

- (A) Mechanical factors
 1 Congenital malformations
 2 Acquired deformations (*ie*, bladder-neck obstruction, stricture, etc)
 3 Malpositions, congenital or acquired
 4 Non-physiologic contents (*ie*, blood concretions, foreign bodies)
- (B) Neurotrophic disturbances
 (Paralysis atony)
- (C) Pregnancy

TECHNICAL NOTES CONCERNING THE ILLUSTRATIONS

The original serial roentgenograms were obtained with the Cinex camera. Exposures ranged from one half to one and one half seconds. Intervals between exposures about one half second for series of several exposures. Åkerlund diaphragm employed routinely. Patients in recumbent position. Respiration arrested in various phases.

Reproductions shown are contact prints wherever insufficient delineation of shadows prevented correct tracing (6 series).

The other series were traced with pointed pencil under reducing lens, printed, silhouetted along tracing line and mounted reversed.

Many series had to be omitted for technical reasons. Acknowledgment is made to Dr C F Hirshfeld and Dr R F James for their assistance.

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tions are well known in the gut—cardio-spasm, pylorospasm, intestinal intussusception of infants, etc—and also occur in the urinary tracts—hydronephrosis and hydroureter of pregnancy due to establishment of a new and more powerful pace-maker than the renal pelvis in the lower ureter, spasticity of renal pelvis during onset of pyelitis, and retention-cystitis

However, the mistiming of bronchial peristalsis seen in one of these asthmatic patients—relaxation on expiration, contraction on inspiration—is a unique record, perhaps only comparable to certain cardiac dysfunctions. The vascular system, when investigated some day by new methods, will yield more analogies, which now may only be the subject of theorizing speculation. New contrast media may open here possibilities for fascinating diagnostic and prognostic, if not also therapeutic endeavor

SUMMARY

(1) A rhythmic, progressive, descend-

ing, pro-peristalsis of the normal renal pelvis is demonstrated by fast serial pyelography (Cinex-camera)

(2) This is different from the “alternating” type of renal peristalsis described by Legueu, Fey, and Truchot, which is considered to be the result of unphysiologic or pathologic conditions, but seems to occur regularly with any instrumental or infectious disturbance in the urinary tracts

(3) Pyelonephritis produces a characteristic alteration of pyelo-peristalsis. This ranges from “alternating” peristalsis over inhibition to complete organic immobilization, depending on type, virulence, duration, location of the infection and the reaction between the infecting agent and the infected host

(4) The characteristic functional effect of low pelvic periureteritis is shown with pro- and anti-peristalsis in the upper uterine segments

(5) Tabulation concerning pyelonephritis

INFECTIONS OF THE URINARY SYSTEM

TABLE II—CLASSIFICATION AND CLINICAL-PATHOLOGICAL TERMINOLOGY

<p>(A) Primarily parenchymal renal infection (descending)</p> <table><tr><td>Bacterial or infectious nephritis with cortical and medullary involvement</td><td rowspan="2">} involvement</td></tr><tr><td>Leading to formation of Renal carbuncle Multiple renal abscesses Septic renal infarcts</td></tr></table> <p>Pyelonephritis acute and chronic</p>	Bacterial or infectious nephritis with cortical and medullary involvement	} involvement	Leading to formation of Renal carbuncle Multiple renal abscesses Septic renal infarcts	<p>(B) Primarily mucosal urinary tract infection (Nephro) pyelitis</p> <p>Leading to development of Pyonephrosis Hydronephrosis Ureteritis</p> <p>Leading to development of Pyoureter Hydroureter</p> <p>Cystitis Urethritis</p>
Bacterial or infectious nephritis with cortical and medullary involvement	} involvement			
Leading to formation of Renal carbuncle Multiple renal abscesses Septic renal infarcts				

(C) Infections primarily involving tissues adjacent to the urinary tracts

(C) Infections primarily involving tissues adjacent to the urinary tracts
Peri nephritis and peri nephric abscess peri ureteritis pelvic adnexitis peri-cystitis peri urethritis

TABLE III—SOURCES AND ROUTES OF URINARY TRACT INFECTIONS

Sources	Routes
<p>A Endogenous (infectious foci) most common in the</p> <p>(1) Alimentary canal including masticatory apparatus</p> <p>(2) Respiratory passages including paranasal sinuses and pharynx</p> <p>(3) Skin (i.e. acne and furunculosis)</p> <p>B Exogenous—most important</p> <p>(1) Cohabitation</p> <p>(2) Trauma including instrumentation</p>	<p>A (1) Blood stream</p> <p>(2) Lymphatic system (doubtful)</p> <p>(3) Direct extension</p> <p>B (1) Urogenital passages (ascending) in connection with Vesico-ureteral reflux Pyelo-venous back flow(?) Tubulo-venous contact</p> <p>(2) Path of implantation in connection with A and B(1)</p>

A CORRELATION OF THE HISTOLOGIC CHANGES AND CLINICAL SYMPTOMS IN IRRADIATED HODGKIN'S DISEASE AND LYMPHOBLASTOMA LYMPH NODES¹

By ALEXANDER BRUNSCHWIG, M D, Department of Surgery and Division of Roentgenology, University of Chicago, and ERNESTINE KANDEL, M D, Department of Medicine, University of Chicago

INTRODUCTION

THERE has been such extensive, and at times confusing, discussion of the etiology and genetic relationship of Hodgkin's disease, lymphosarcoma and the leukemias, that it is necessary for anyone presenting a paper on the subject to define his own views. There is no question but that a typical Hodgkin's disease lymph node presents a characteristic histologic picture. Typical lymphosarcomas also constitute a pathologic entity. In lymphatic leukemia, the involved lymph nodes are practically identical in structure with lymphosarcoma, but in the former, the blood picture characterizes the condition. The infectious nature of Hodgkin's disease, especially in regard to tuberculosis, has not yet been conclusively demonstrated. Lymphosarcoma and lymphatic leukemia are considered true neoplastic diseases. There are, however, instances in which a histologic differentiation of Hodgkin's disease from lymphosarcoma or leukemias is impossible, even by the most expert pathologists. Warthin (1) cited such cases as evidence that all of these conditions are but variations of the same fundamental neoplastic process. He also reported cases of Hodgkin's disease that finally developed into leukemia.

A close relationship between lymphosarcoma and lymphatic leukemia has also been repeatedly demonstrated by those cases which were first lymphosarcoma and later developed into lymphatic leukemia (Kato and Brunschwig, 2). In fact, it appears that lymphosarcoma is a preliminary stage of lymphatic leukemia.

The use of the term "Hodgkin's disease" or "lymphogranuloma" is justifiable in

typical cases. The term "lymphoblastoma" has been employed to designate Hodgkin's disease, lymphosarcoma, and the lymphatic leukemias, collectively, but the writers prefer to apply it only to the two latter conditions.

It is generally admitted that the treatment of choice for this group of lymphoid neoplasms is irradiation. Excision of the affected lymph nodes is justified only in unusual circumstances. But experience has shown that, with few exceptions, irradiation therapy is at best palliative. A fatal outcome within from 3 to 5 years or less is the rule. However, a few proven cases of many years' duration are on record.

It seems paradoxical that the immediate results of irradiation therapy should be so satisfactory, and yet so little be accomplished toward permanent eradication. There is, as yet, no explanation for this. Histopathologic studies of irradiated Hodgkin's nodes have been recorded by a number of authors (Mayer, 3, Symmers, 4, Favre and Croizat, 5), but without close correlation with the clinical course. A short time after irradiation, foci of necrosis appear in the affected nodes with rather extensive cellular destruction. A diffuse sclerosis develops that ultimately replaces a large part of the cellular tissue. It has also been pointed out that in patients, who did not receive irradiation, such a sclerosis of the diseased lymph nodes will often develop spontaneously, so that the post-irradiation nodes and old untreated nodes in Hodgkin's disease may present the same histologic structure. Very few observations on irradiated lymphoblastoma are recorded. Warthin (6) made extensive studies on two postmortem cases which had received generalized irradiation for some time. He found a generalized sclero-

¹ Read before the American Congress of Radiology, at Chicago, Sept. 27-30, 1933.

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sis in the bone marrow, spleen, and lymph nodes

The following studies were made in order to correlate the clinical course of these conditions with the histologic changes in the irradiated tissue, and to determine, if possible, the reason for the failure of irradiation therapy to eradicate the disease

The Affect of Irradiation on Normal Lymph Nodes—As a control for the changes in Hodgkin's and lymphoblastoma nodes, to be described below, it is necessary to determine what effect irradiation has on normal lymphoid tissue Ewing, Quick, and Cutler have demonstrated that, contrary to the earlier notions, normal lymph nodes are not sclerosed by extensive irradiation They are, in fact, quite re-

sistant, and even undergo hyperplasia, the germinal follicles becoming prominent and containing numerous mitotic figures The writers confirmed these observations in a lymph node removed from the cervical region along with a large neurofibroma of the brachial plexus, that had been irradiated some time prior to operation

In the following cases, seen in the University of Chicago Clinics, the total doses employed in any series of treatments were from 500 to 800 r to one field (measured in air), delivered to the affected group of lymph nodes and sometimes to the adjacent groups which were not clinically involved (200 P K, 25 ma, 50 cm focal skin distance, 0.5 mm Cu plus 1 mm Al filter)

HODGKIN'S DISEASE

CLINICAL HISTORY

Case I E O, male, aged 16 years was admitted to the hospital in September, 1930, because of swollen upper right cervical lymph nodes of 4 months' duration, which formed a large mass about $6 \times 4 \times 4$ centimeters There were no general symptoms Physical examination was otherwise essentially negative Spleen was not palpable Blood was normal

Deep x ray therapy was given to the left and right cervical regions followed by a complete regression of the mass

In January 1932 the patient's general health was unimpaired Small shotty movable lymph nodes were felt in the right cervical region A biopsy was performed

In May, 1933 the patient is markedly emaciated weak and pale He cannot gain weight in spite of forcing himself to eat On physical examination there are no enlarged superficial lymph nodes palpable Nodes in the right cervical region are normal in size but firm and shotty Spleen not palpable There are no retroperitoneal masses Roentgenogram of chest shows no

HISTOLOGIC FINDINGS

Biopsy of the cervical mass was done on admission Section shows a dense cellular overgrowth composed of lymphocytes, plasma cells some eosinophil and reticulum cells (Dorothy Reed) that have almost completely destroyed the normal lymph node architecture There still remains a number of small scattered normal germinal centers surrounded by narrow zones of normal lymphocytes In places there are large swollen endothelial cells There is also a slight diffuse sclerosis

Diagnosis Hodgkin's disease (Fig 1)

Biopsy sections of small right cervical lymph node showed almost complete replacement by dense fibrous and hyalinized tissue Just beneath the capsule there are several small groups of large and small lymphocytes and plasma cells (Fig 2)

In May 1933 a biopsy of two right cervical lymph nodes was done Sections of one node are practically identical with those just described except for slightly more cellular tissue beneath the capsule Sections of the other node also reveal marked central sclerosis but there are rather large areas of large and small lymphocytes plasma cells and a number of re-



Fig 1 Case I (Hodgkins disease) Photomicrograph ($\times 25$) of section from initial biopsy, showing dense cellular overgrowth, with scattered foci of normal lymphocytes and large normal germinal centers



Fig 2 Case I Photomicrograph ($\times 20$) of section from lymph node removed after therapeutic irradiation. The greater portion of the gland has been sclerosed but islands of neoplastic tissue persist beneath the capsule (A)



Fig 3 Case I Photomicrograph ($\times 25$) of right cervical node showing histologic picture for recurrence. There is a proliferation of the subcapsular neoplastic remnants with invasion of surrounding fibrous tissue especially toward the center of the node. Compare with Figure 2 which shows the latent period shortly after irradiation



Fig 4 Case II Photomicrograph ($\times 25$) of left cervical lymph node some time after therapeutic irradiation. Enlargement did not recur in this group as it did in the opposite side because there has been complete sclerosis of the node and disappearance of practically all neoplastic tissue

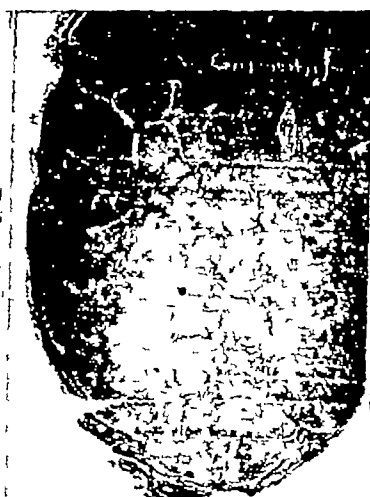


Fig 5 Case IV Photomicrograph ($\times 20$) of biopsy section from left cervical mass. There is a dense overgrowth of lymphoblasts that has destroyed the normal lymphoid architecture. No sclerosis. Diagnosis Lymphogblastoma (lymphosarcoma)



Fig 6 Case IV Photomicrograph ($\times 20$) of section from left cervical mass removed at autopsy. Therapeutic irradiation was completed four weeks before resulting in a clinical improvement. The patient became ill with acute lymphatic leukemia six days before death. There is a moderate diffuse sclerosis with accumulation of round cells (lymphoblasts) beneath the capsule. Compare with Figure 5 which shows the absence of sclerosis before irradiation

CLINICAL HISTORY—*Cont'd*

The lower left cervical nodes were also enlarged but discrete. There were no generalized symptoms, no anemia. Roentgenograms of chest showed no mediastinal masses.

One month later, he received x-ray therapy to both cervical regions. This was followed by complete regression of the masses.

Two months after roentgen therapy a second biopsy was performed on a small firm lymph node in the left cervical region. There were no generalized symptoms, no anemia. General condition was satisfactory.

lymph nodes has been completely destroyed except for an occasional large focus of normal lymphocytes, obviously a remnant of the normal lymphoid tissue.

Diagnosis: Hodgkin's disease.

July, 1933 another small firm lymph node was removed from the left cervical region.

Biopsy, July 26, 1933. Sections showed a rather marked diffuse sclerosis in which the fibroblast nuclei were large. There were also many large reticulum cells tending to form large foci. Scattered in the sclerotic background were a moderate number of round cells, lymphocytes, and lymphoblasts, and plasma cells and a large number of eosinophils.

From Aug. 12 to 19, 1932, he received x-ray therapy to both cervical regions.

In October, 1932, he returned to the clinic because of a mass 4 cm. in diameter in the left axilla. He had lost a little weight and felt weak. White blood count, 3300; hemoglobin, 64 per cent; and red blood count, 3900000. No other superficial nodes were palpable. X-ray therapy was given to the left axilla.

On Dec. 23, 1932, the patient was readmitted to the hospital because of marked weakness and evening rise in temperature to 103° F. and loss of weight. White blood count 1600; hemoglobin 66 per cent; red blood count 5080000. Superficial lymph nodes were not enlarged; spleen not palpable; and roentgenograms of chest showed no mediastinal masses. Patient not seen since this admission.

Case IV. J. F., male, aged 18 years, was admitted on Nov. 14, 1928. He presented enlarged firm left cervical and left axillary lymph nodes of 13 months' duration. There were no general complaints. Blood picture was normal.

Biopsy, Nov. 14, 1928, of left cervical node. Sections show destruction of normal lymph node architecture by dense cellular overgrowth of large and small lymphocytes, plasma cells, some eosinophils, and scattered reticulum cells. There was also a slight diffuse sclerosis.

There was a regression of masses following deep x-ray therapy and series of injections of Colley's toxins.

CLINICAL HISTORY—*Cont d*

mediastinal masses Blood red blood count 4 520 000, hemoglobin 76 per cent, white blood count, 10,800

HISTOLOGIC FINDINGS—*Cont d*

ticulum cells beneath the capsule This cellular tissue appears to be infiltrating into the central sclerotic area of the node (Fig 4)

Case II J C, male, aged 28 years, was admitted to the hospital in October 1931 because of swollen bilateral cervical lymph nodes The patient had been aware of these masses for the previous four years yet experienced no general symptoms until two years ago, when he began to lose weight and felt constantly fatigued On physical examination, the lymph nodes in both cervical regions were found to be enlarged to about 3 to 4 cm in diameter firm, movable, and for the most part, discrete, there was also slight enlargement of axillary and inguinal nodes Liver was 1.5 cm below costal margin spleen was just palpable. Roentgenograms of chest showed a mediastinal mass with extension into the hilum of the right lung White blood count, 8 000 hemoglobin 58 per cent, red blood count 3 980,000

Biopsy Oct 5 1931 The section shows three nodes adherent to one another by their dense fibrous capsules No normal lymphoid architecture is present It has been replaced by a dense cellular overgrowth of lymphoblasts lymphocytes plasma cells and eosinophils Large reticulum cells are numerous and aggregated into large foci In places there has been a marked proliferation of endothelial cells plugging up the few remaining visible sinuses In addition to a diffuse sclerosis there are many scattered round hyalinized masses
Diagnosis old Hodgkin's disease

From October to November 1931 the patient received deep x-ray therapy to both sides of neck chest, and inguinal regions followed by regression of the enlarged nodes to almost normal size There was no improvement in the anemia, in spite of adequate iron therapy, there was little improvement in strength

In March 1932, although the patient had no complaints he was pale and emaciated, lymph nodes almost normal in size Spleen was barely palpable.

In June, 1932 the lymph nodes in right side of neck had rapidly increased to 3 to 4 cm in diameter and had become quite tender The nodes in left cervical region were not enlarged General condition was poor Evening rise in temperature to 101° F White blood count 8 000 red blood count 3 090 000 differential normal hemoglobin 32 per cent A biopsy was done of nodes in both cervical regions Patient appeared too weak for further roentgenotherapy

Biopsy, June 24 1932 Sections of the enlarged node removed from the right side show a dense sclerosis and numerous foci of necrosis about which were many polymorphonuclear cells There are also many scattered areas of round cells and reticulum cells each forming a small focus of 'Hodgkin's disease tissue' The section of the lymph node removed from the left cervical region where enlargement of the nodes did not recur show it to be composed of dense fibrous tissue with few nuclei There are a few scattered foci of lymphocytes with no associated eosinophils or reticulum cells These foci do not suggest remnants of the Hodgkin's tissue but appear to be a part of the sclerotic process that has involved the whole node (See Fig 4)

In March 1933 the patient died

Case III J K male aged 30 years was first seen on March 8 1932 complaining of a large, firm painless swelling 5 × 4 × 4 cm below the angle of the left mandible, that had developed in the last two months This was due to enlarged confluent upper cervical nodes

On March 8 1932 a biopsy of enlarged left cervical node showed a dense overgrowth of lymphocytes some plasma cells and lymphoblasts eosinophils and an occasional reticulum cell There were small scattered areas of slight sclerosis The architecture of the normal

LYMPHOSARCOMA AND LYMPHATIC LEUKEMIA

CLINICAL HISTORY

Case V M K, female child, aged 5 years, was admitted on Jan 7, 1932 because of enlarged confluent left cervical lymph nodes which had formed a mass $8 \times 5 \times 5$ cm and about which were other discrete enlarged nodes. There was no pain or tenderness. Physical examination otherwise negative. White blood count, 6,200, red blood count, 5,300,000, hemoglobin 98 per cent differential normal.

During the next three weeks, the patient received deep x ray therapy to left and right cervical regions, left and right inguinal regions, left axilla and mediastinum. A few days after treatment began, there was marked regression of the left cervical mass, which almost completely disappeared a little later.

On Feb 29, 1932 the patient was readmitted in a toxic condition with moderate enlargement of the left cervical nodes and slight enlargement of the right cervical nodes. A few days previously there had been an evening rise in temperature to 102°F , and hematuria. There were purpuric spots on the extremities and trunk, and bleeding from the gums. The liver and spleen were palpable. Red blood count, 2,740,000, white blood count, 179,000, consisting of 98 per cent immature lymphocytes. Diagnosis acute lymphatic leukemia. The patient died in March, 1932.

Case VI C B female, aged 49 years was admitted on April 3, 1933 because of a slowly growing mass in the right side of the neck present since December 1932, and tender at intervals. This mass was $8 \times 5 \times 5$ cm, and obviously due to enlarged confluent, firm upper cervical lymph nodes. The lower right cervical nodes were discrete, rubbery, and moderately enlarged. White blood count, 6,200, hemoglobin, 80 per cent, red blood count 3,600,000. Biopsy of the mass was done.

From April 6 to 12, 1933 deep x ray therapy to both sides of the neck and right axilla.

In May, 1933 her general condition was excellent but the mass had not regressed more than one third in size. Because of this it was removed surgically. A few weeks later a second course of deep x ray therapy was given. White blood count 6,300, hemoglobin 65 per cent.

HISTOLOGIC FINDINGS

Biopsy, Jan 7, 1932, of the left cervical mass. Sections reveal normal lymphoid architecture completely replaced by a dense overgrowth of lymphoblasts, exhibiting numerous mitotic figures. There is beginning invasion through the capsule and into the surrounding areolar tissue (Fig 5). Diagnosis lymphoblastoma (lymphosarcoma).

Section from a lymph node in the left cervical region taken at postmortem examination on March 2, 1932 showed a rather marked diffuse sclerosis. Large round cells (lymphoblasts) were present in moderate numbers. In the central area of the node they were uniformly scattered in the fibrous tissue. Beneath the capsule they were more numerous and aggregated into large dense foci. An occasional plasma cell eosinophil was present. There were also small scattered areas of cellular necrosis.

Biopsy sections revealed no normal lymphoid structure. Instead, this had been replaced by a dense overgrowth of large lymphoblasts exhibiting a moderate number of mitotic figures. Some fibrous bands were present but there was no diffuse sclerosis. Diagnosis Lymphoblastoma (lymphosarcoma).

Biopsy one month after completion of deep x ray therapy. Sections of the partially regressed mass show a marked diffuse sclerosis throughout and diffusely scattered round and oval cells (lymphoblasts) presenting a few mitotic figures. There are a few polymorpho-

CLINICAL HISTORY—*Cont'd*

In June, 1930, the patient was readmitted for recurrence of masses in left cervical and axillary regions. He stated that they began to develop six months after last admission and x ray therapy. Other complaints were weakness, and loss of 14 pounds in weight. Roentgenograms of the chest showed upper mediastinal mass. Biopsy of left cervical lymph node was done. There was no anemia.

Deep x ray therapy to left axillary, cervical, and mediastinal regions, followed by regression of the lesions and improvement in general symptoms.

In October, 1931, the patient was readmitted because of recurrence of weakness, loss in weight, and reappearance of tumor masses, in last four months in both axillae. They were not as large as before, now measuring about 2 cm in diameter. Spleen was not palpable. Roentgenograms of chest showed no recurrence of mediastinal mass, red blood count, 3,000,000, hemoglobin 39 per cent, white blood count 8,000. Temperature, 101–103° F each evening.

The patient was too ill for x ray therapy.

In January, 1932, he expired 5 years after onset of symptoms.

In all the cases described above, the patients were benefited temporarily by irradiation, but no permanent cure was obtained. This improvement is represented histologically by a sclerosis of the nodes, a result of therapy. The sclerosis, however, is not complete because some of the neoplastic tissue survives in small quantities beneath the capsules of the nodes and is scattered throughout the central portions. The post-irradiation improvement continues for a varying period until there is a return of generalized symptoms and sometimes local and distant recurrence of enlarged nodes. The recurrence of local and general symptoms is represented histologically by a "lighting-up" of activity in the small patches of neoplastic tissue remaining within the sclerotic nodes. There is a proliferation of these cells with invasion of the surrounding fibrous tissue. Depending upon

HISTOLOGIC FINDINGS—*Cont'd*

Biopsy June 1930 of the left cervical lymph node shows a marked increase in diffuse sclerosis. Many large fibroblast nuclei were present. Large and small lymphocytes, lymphoblasts, plasma cells, and some eosinophils were scattered diffusely in the fibrotic node. There was an increase in number of reticulum cells as compared with the first sections.

Biopsy October, 1931, of a lymph node in left cervical region. Sections show a dense sclerosis with hyalinization in certain areas and foci of necrosis. Many fibroblast nuclei are seen but round cells are also present as a diffuse and focal infiltration. There are many scattered eosinophils, and associated with some of the larger accumulations of round cells are a number of reticulum cells.

the extent of recurrence, the lymph nodes again become quite cellular, or may remain sclerotic with large scattered cellular areas. However, there is never a return to the very cellular state that obtains before therapy. The sclerosis produced by irradiation will persist and is readily recognized, although it may become invaded again by round cells as a result of subsequent recurrences. If irradiation does not produce a rather extensive sclerosis, the immediate prognosis is poor, as illustrated by Case III.

In addition to sclerosis, two other features especially characterize an irradiated Hodgkin's node. First, the large number of eosinophils, and second, an increase (quite marked in some cases) of reticulum cells as compared with the number present before irradiation. At this time it is not possible to interpret these histologic findings

CLINICAL HISTORY—*Cont'd*

In April, 1933 his general condition was excellent and he was doing hard physical work. All nodes were normal in size, but could be readily palpated because of their firmness.

Case VIII H B, male, aged 72 years was admitted on Aug 29, 1931, presenting painless swollen lymph nodes, about 4 cm in diameter in both cervical and axillary regions, of three months duration. Physical examination was otherwise negative. Biopsy was done of a left cervical node. There were no general symptoms. White blood count 17,900, differential, polymorphonuclears, 44 per cent, large lymphocytes 12 small lymphocytes 42 per cent, mononuclears, 2 per cent.

In September and October, 1931, he received deep x ray therapy to right and left cervical and axillary regions. There was a regression of enlarged nodes to almost normal size.

In January, 1932, x ray therapy was repeated.

In April, 1932, there was a recurrence of egg sized nodes in cervical, axillary, and inguinal regions. There were no general complaints. The blood picture was as before except for immature appearance of lymphocytes. These masses regressed under a third course of deep x ray therapy.

In September, 1932, there was a second recurrence of enlargement of cervical nodes. Biopsy was done of a node in the left cervical region.

In October, the blood count was as follows: white count, 32,000, polymorphonuclears 12 per cent, lymphocytes 87 per cent, red blood count, 4,140,000, hemoglobin, 98 per cent. Diagnosis: Chronic lymphatic leukemia.

Deep x ray therapy to cervical regions repeated with regression of masses.

In December 1932 the patient was readmitted to the hospital suffering from lobar pneumonia—entire right lung. Superficial lymph nodes were small but firm. White blood count, 110,000 91 per cent of which were small lymphocytes. The patient died.

HISTOLOGIC FINDINGS—*Cont'd*

Biopsy, April, 1933, of a left cervical node revealed essentially the same picture as described above, namely, a lymph node the normal structure of which was replaced by a dense cellular growth of cells closely resembling lymphocytes. *No sclerosis was present.*

Biopsy. Sections from the excised lymph node revealed a replacement of the normal lymph node structure by a dense overgrowth of large round cells (lymphoblasts), exhibiting a moderate number of mitotic figures. There was no sclerosis. Diagnosis: lymphoblastoma (Fig 7).

Biopsy sections showed essentially the same picture as described above. There was no sclerosis.

A section of a lymph node, removed from the left cervical region at postmortem examination, showed essentially the same structure seen on the initial biopsy. *No sclerosis was present.* There were a few scattered hyalinized areas but these were similar in appearance to those often seen in the germinal centers of normal hyperplastic nodes and were obviously not the result of irradiation. Diagnosis: chronic lymphatic leukemia (Fig 8).

CLINICAL HISTORY—*Cont d*

red blood count, 3 710,000 Smears showed no atypical leukocytes

HISTOLOGIC FINDINGS—*Cont d*

nuclear and plasma cells There are no foci of necrosis no dense hyalinized stroma

Died at home in November 1933, with recurrent masses in right cervical region and mediastinum

Case VII E D, male aged 58 years janitor, was admitted in April 1932, because of nodular swellings in the groins and axillæ The patient stated that he had been aware of these masses for the last 15 years, that they varied in size and never were accompanied by constitutional disturbances However in the last two months an increase in their size was accompanied by a progressive weakness which prevented him from working Physical examination revealed cervical, axillary, and inguinal nodes measuring about from 3 to 5 cm in diameter, discrete and movable The spleen was palpable three fingers' breadth below the costal margin Blood picture was normal, roentgenograms of chest showed no mediastinal mass

Biopsy of left cervical node revealed a replacement of the normal lymphoid architecture by a dense overgrowth of cells, closely resembling mature lymphocytes—a few mitotic figures were present There was no sclerosis Diagnosis lymphoblastoma (lymphocytoma)

From April 25 to May 9, 1932, deep x ray therapy to all superficial groups of nodes that were clinically involved and to the mediastinum

By June, 1932 all nodes had regressed to normal size except in the inguinal regions, where they remained slightly enlarged Weakness had disappeared

In August, 1932, improvement was maintained The patient was at work

Biopsy August, 1932, of a small firm nodule in the left cervical region Sections showed a small node in which the normal architecture was destroyed due to a dense overgrowth of cells closely resembling normal lymphocytes There was no sclerosis essentially the same picture as seen above

In October, 1932 the patient was readmitted because of extensive edema of the scrotum and inferior extremities, and marked weakness Physical examination also revealed a large abdominal mass due to involved retroperitoneal lymph nodes White blood count 5 000 Differential was normal

Deep x ray therapy to the abdomen

In December 1932 edema and retroperitoneal masses had disappeared Patient felt practically well

that the theory of Regaud, for the growth and development of squamous-cell carcinomas, is perhaps also true for Hodgkin's sarcoma. For, according to this theory, the growth of a neoplasm is similar to the proliferation of a seminal epithelium. There are "mother cells" that divide, giving rise to similar "mother cells" and "daughter cells," the former corresponding to the spermatogonia, and the latter, maturing more than the former, correspond to primary and secondary spermatocytes and spermatozoa. The "daughter cells" are radiosensitive and are easily destroyed. The "mother cells" are radio-resistant and destroyed only with difficulty. Hence, when recurrences develop after irradiation, it is from the "mother cells" that have persisted.

Thus, in Hodgkin's disease, if it is true that from the beginning the process involves the entire reticulo-endothelial system, irradiation therapy has little more than palliation to offer. On the other hand, if it begins as a local process and the primarily involved group of lymph nodes is discovered on physical examination early in the course of the disease, heavy irradiation of this and adjacent groups, with the object of completely sclerosing the affected nodes, offers a possibility of improving the therapy of this condition.

The problem in lymphoblastoma is more complicated. It is possible, in the more chronic cases, to reduce the enlarged nodes to normal size, yet, biopsy reveals that these small post-irradiation nodes are not sclerotic but are as cellular as the initial growth, containing large numbers of viable tumor cells. In the two cases of lymphoblastoma reported above, in which moderate diffuse sclerosis did occur, the clinical course indicated that the progress of the disease was not very favorably influenced by such changes.

However, small scattered masses of neoplastic tissue usually survive beneath the capsule or within the central portion of the sclerotic node. This indicates a variation in radiosensitivity of the Hodgkin's disease tissue.

After a latent period this cellular tissue begins to proliferate and infiltrate the surrounding sclerotic areas. This constitutes a recurrence. Increased numbers of reticulum cells and eosinophils usually characterize the histologic appearance of such recurrences. The clinical improvement coincides with the sclerosis of the nodes, and the recurrence of general symptoms corresponds to the proliferation of the neoplastic tissue after the initial sclerosis of the node.

(2) As shown in one case reported above (Case II), almost complete sclerosis of Hodgkin's nodes can be brought about by irradiation. When this obtains, the possibility of local recurrence is greatly minimized.

(3) If, as has been maintained, Hodgkin's disease affects the entire reticulo-endothelial system from the start, little more than palliation can be expected from irradiation therapy. On the other hand, if the process is at first a local one, and if the involved group of lymph nodes is discovered on physical examination early in the progress of the disease, intense local irradiation, with the object of completely sclerosing the lymph nodes, may offer a possibility of arresting the process.

(4) Irradiation of lymphoblastoma nodes may result in a reduction in size and some sclerosis, if the process is of the more malignant type. In the chronic cases, the nodes are reduced in size but not sclerosed.

(5) From the histologic standpoint lymphoblastoma is more radioresistant than Hodgkin's disease.

SUMMARY AND CONCLUSION

(1) Irradiation of Hodgkin's lymph nodes according to the usual technique, results in a widespread replacement of the cellular tissue by dense sclerosis.

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The four cases described above may be divided clinically into two groups. Cases V and VI may be considered quite malig-

DISCUSSION

From the above studies, it is apparent

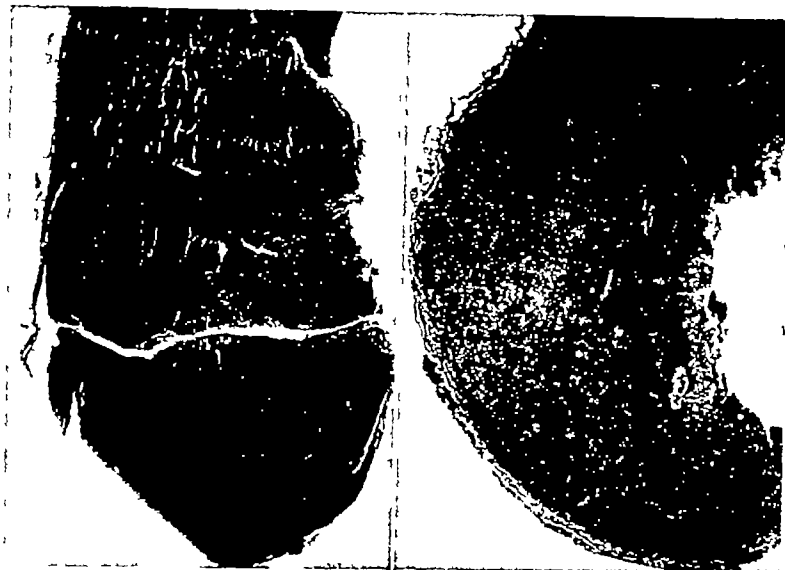


Fig 7 Case VIII Photomicrograph ($\times 20$) of biopsy section from left cervical mass before therapeutic irradiation. Normal lymph node structure has been completely destroyed by dense overgrowth of mature lymphoblasts. Diagnosis: Lymphoblastoma (chronic lymphatic leukemia).

Fig 8 Case VIII Photomicrograph ($\times 20$) of section from left cervical node removed at post mortem. Although nodes in this region were irradiated on several occasions and twice reduced to normal size there is no sclerosis, the node being as cellular as at the initial biopsy (Fig 7).

nant because, in one, shortly after irradiation, a rapidly fatal acute leukemia developed, and in the other, there was not a satisfactory regression of the tumor mass. Cases VII and VIII may be regarded as less malignant because, in one, the disease has been present for many years, and in the other, it pursued a chronic course for two years after irradiation therapy was first instituted, the patient dying of an intercurrent infection. There is also a marked difference in the histologic reactions of these two groups to irradiation. In the more acute or malignant cases, there was a diffuse sclerosis of the irradiated nodes. In no instance, however, did this sclerosis compare with that seen in the Hodgkin's nodes. In the more chronic or less malignant cases the nodes were reduced in size but there was no sclerosis.

that irradiation therapy did not in any instance cause a complete disappearance of the neoplastic tissue. In Hodgkin's disease, improvement was brought about by materially reducing the quantity of the neoplastic tissue, but recurrences developed from the small amounts that remained.

Since each node received practically the same irradiation throughout, the persistence of small amounts of neoplastic tissue beneath the capsule and as small foci in the central portions of the node indicates a difference in radiosensitivity within this tissue. This would explain the apparent increase in radioresistance of each recurrent enlargement, since in such recurrences the neoplastic tissue is derived by proliferation of the more radioresistant cells. Thus the apparent existence of radioresistant and radiosensitive cell strains in Hodgkin's disease would indicate

that the theory of Regaud, for the growth and development of squamous-cell carcinomas, is perhaps also true for Hodgkin's sarcoma. For, according to this theory, the growth of a neoplasm is similar to the proliferation of a seminal epithelium. There are "mother cells" that divide, giving rise to similar "mother cells" and "daughter cells," the former corresponding to the spermatogonia, and the latter, maturing more than the former, correspond to primary and secondary spermatocytes and spermatozoa. The "daughter cells" are radiosensitive and are easily destroyed. The "mother cells" are radio-resistant and destroyed only with difficulty. Hence, when recurrences develop after irradiation, it is from the "mother cells" that have persisted.

Thus, in Hodgkin's disease, if it is true that from the beginning the process involves the entire reticulo-endothelial system, irradiation therapy has little more than palliation to offer. On the other hand, if it begins as a local process and the primarily involved group of lymph nodes is discovered on physical examination early in the course of the disease, heavy irradiation of this and adjacent groups, with the object of completely sclerosing the affected nodes, offers a possibility of improving the therapy of this condition.

The problem in lymphoblastoma is more complicated. It is possible, in the more chronic cases, to reduce the enlarged nodes to normal size, yet, biopsy reveals that these small post-irradiation nodes are not sclerotic but are as cellular as the initial growth, containing large numbers of viable tumor cells. In the two cases of lymphoblastoma reported above, in which moderate diffuse sclerosis did occur, the clinical course indicated that the progress of the disease was not very favorably influenced by such changes.

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However, small scattered masses of neoplastic tissue usually survive beneath the capsule or within the central portion of the sclerotic node. This indicates a variation in radiosensitivity of the Hodgkin's disease tissue.

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(2) As shown in one case reported above (Case II), almost complete sclerosis of Hodgkin's nodes can be brought about by irradiation. When this obtains, the possibility of local recurrence is greatly minimized.

(3) If, as has been maintained, Hodgkin's disease affects the entire reticulo-endothelial system from the start, little more than palliation can be expected from irradiation therapy. On the other hand, if the process is at first a local one, and if the involved group of lymph nodes is discovered on physical examination early in the progress of the disease, intense local irradiation, with the object of completely sclerosing the lymph nodes, may offer a possibility of arresting the process.

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ROENTGEN-RAY VISUALIZATION OF PART OF THE LYMPHATIC SYSTEM

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BECAUSE the origin and anatomic arrangements of the lymphatics were not clearly understood for a long time conflicting views were advanced in an attempt to explain the method of lymphatic absorption of particulate matter and micro-organisms. Some authorities believe that the lymphatics originate in the tissue spaces directly drained by lymph capillaries; others believe that the lymphatics are a closed system of vessels, comparable with the blood vessels.

It can be appreciated that the mode of entrance of solid particles, such as pigments or micro-organisms, into the lymphatic system will depend in a large measure upon the anatomic arrangement of the latter. If the lymphatic vessels originate as tissue spaces, minute solid objects would enter directly into the lymphatics without difficulty, but if the lymphatics are a closed system, entrance into them could be accomplished only by living cells, acting as phagocytes, passing into the lymph by diapedesis. Many experiments have been conducted by numerous observers in an attempt to clarify the mode of absorption of the lymphatic system. Outstanding is the work of Herring and MacNaughton (1). By injecting insoluble substances such as carbon and carmine, into the subcutaneous tissues of the legs of animals and recovering them in the lymph nodes, these two workers have been able to prove that the lymphatic system absorbs the substances. They also found that the tissue spaces are not directly continuous with the lymph capillaries and that the injection of insoluble substances, such as India ink and carmine, into the loose connective tissues may spread them widely through the tissue spaces. Herring and MacNaughton conclude that many of these solid particles are taken up in the cyto-

plasm of cells which passes through the walls of the lymphatics by diapedesis into the lymphatic system.

Their contention is "The phagocytic cells are arrested in the first lymph gland on the lymph stream, and the cells carrying solid particles pass from the lymph sinuses of the gland into the lymph tissue of the cortex and medulla of the gland, and eventually discharge their burden among the lymphocytes in these situations. Solid particles, and even red corpuscles, arriving at the gland in a free state in the lymph stream, are dealt with by the endothelial cells of the reticulum of the lymph tissues. These cells, analogous to the Kupffer's cells of the liver sinusoids, ingest material, detach themselves, and carry into the lymphoid tissue of the gland in exactly the same way."

This is the explanation of the mode of absorption by the lymphatics when thorium dioxide, subcutaneously injected, is used to visualize the lymphatic system. Thorium dioxide, being a colloidal preparation containing particles of thorium, its absorption by the lymphatic system should be like that of India ink and carmine, as found by Herring and MacNaughton in their experiments.

In a preliminary report (2) and paper (2a), we reported that it was possible to visualize lymph nodes and vessels by subcutaneous injection of thorium dioxide without resorting to the surgical means previously used by others. Carvalho and his co-workers (3) have reported that they were able to visualize lymphatic vessels by surgically injecting certain opaque substances directly into the lymph nodes. They stated that in work planned for the future they would outline their technique and indicate the opaque substances used in their experiments, as well as their re-

sults While their experiments are interesting, they have but little practical application, with them, it becomes necessary to dissect the nodes surgically in preparation for injection Again, it can be appreciated that, unless the body was subjected to a general dissection, it would be practically impossible to find many such nodes to be injected

Since the publication of our preliminary report on the visualization of portions of the lymphatic system, we have been able to visualize other portions beside those reported in our previous work, employing in these experiments the intraperitoneal and intradermal methods of injection Some of these later observations have been published in certain medical journals, others, we present now for the first time In a recent issue of the *Proceedings of the Society of Experimental Biology and Medicine* appears a preliminary report on the roentgen-ray study of absorption of thorium dioxide from the peritoneal cavity of the albino rat (4) We were able to demonstrate that, when thorium dioxide is injected into the peritoneal cavity of a rat, it is quickly absorbed by the lymphatic system of the diaphragms, and then is apparently carried by the lymphatics of the thorax into the right and left lymphatic ducts

By means of roentgen-ray films we were able to show very fine striations in the abdomen which closely resembled lymph vessels, as we reported earlier The diaphragms showed an accumulation of thorium, suggesting absorption, in their lymphatics The thorax clearly showed the intercostal glands and vessels, and the connection of these vessels with what may be the right and left lymphatic ducts Thus we demonstrated the drainage system of the lymphatics from the peritoneal cavity, diaphragm, intercostal nodes and vessels, and into the lymphatic ducts We believe that this is the first time this portion of the lymphatic system has been visualized with the roentgen ray The intraperitoneal injection of thorium dioxide did not injure the rats—they remained in perfect health for months

Recently we injected thorium dioxide into the peritoneal cavity of dogs and rabbits, observing the route of absorption by the lymphatic system It was similar to that seen in the rat, but a different portion of the lymphatic system of the thorax was visualized because the lymphatic system of the dog and rabbit differs from that of the rat In the dog there is an absence of intercostal lymph vessels and glands, prominent in the rat We were able to clearly visualize the right and left sub-sternal glands, situated on the course of the internal thoracic vessels, also the anterior mediastinal gland In the posterior mediastinum we found a clump of glands, probably the tracheo-bronchial lymph nodes Surrounding and also near the trachea were found lymph structures, probably the lymph glands which occur on the ventral face of the trachea and esophagus, and also the glands usually present between the trachea and the thoracic inlet and those on the right side of the trachea The anterior and posterior mediastinal lymph vessels were clearly visualized, beginning in the region of the diaphragm and finally ending in the region of the lymphatic ductus We believe that this is the first time it has been possible to study the lymphatic system of the thorax of the dog

The experiments reported here not only demonstrate that thorium dioxide, when injected into the peritoneal cavity, can be used as a diagnostic aid through the visualization of certain lymphatic structures of the diaphragm and thorax, but that it is helpful for a clearer understanding of the high phagocytic capability of the lymphatic endothelial cells in removing large amounts of particulate matter from the peritoneal cavity, by the roentgen visualization of certain of these structures We are inclined to believe with Cunningham (5) that the transfer of granular material from the peritoneal cavity into the diaphragmatic lymphatics takes place by means of a type of phagocytosis The practical application of this knowledge is found in the well-known Fowler position in which, upon elevation of the head of

the bed after operations for abdominal infections, the infected material is permitted to gravitate toward the pelvic peritoneum. Here absorption takes place with comparative slowness, while the peritoneum in the upper abdomen absorbs very rapidly.

We consider our reported experiments on the visualization of different portions of the lymphatic system to be of value both from a diagnostic and a therapeutic standpoint. The possible visualization of lymph nodes in man could be of invaluable assistance to the surgeon in locating metastatic nodules before and after operation and in observing the effect of irradiation on certain glandular diseases. Lymphatic visualization would also be of considerable help to internists in the diagnosis and treatment of certain diseases which have a direct relation to the lymphatic system.

While we have reported that it is possible to visualize normal lymph nodes and vessels of different portions of the lymphatic system in the living, it should be appreciated that it may be shown in the future that diseased lymph nodes may or may not lend themselves to being visualized by the injection of thorium dioxide. It is probable that certain pathologic changes occurring within the internal structures of lymph nodes as a result of disease, prevent the absorption of thorium in sufficient quantity to cast a shadow. We have particularly in mind lymphatic metastasis. If it should be shown that metastatic lymph nodes are not susceptible to visualization, this fact alone could be of great diagnostic importance. We are at present making certain investigations in this regard, and hope soon to be able to publish our results.

We believe that if it can be shown that metastatic nodules absorb thorium, it may prove a most important factor in the treatment of cancer, in spite of the report of Irwin (7), who states that he did not find signs of any pathologic process in lymphatic nodules which had absorbed thorium. We base our belief partly on the report of the histopathologic examina-

tions of some of the lymph nodes of normal dogs which had absorbed a certain amount of thorium (6). Harris says "In the case of the animals employed in these experiments, which were injected subcutaneously, the lymphatic glands being thereby visualized, there occurs a distinctly stimulating reaction upon the connective tissues, or stromal unit of the glands, with loss of the lymphoid structure. At times, associated with the connective tissue increment, there occurs an enlargement and evident stimulation of the cortical nodules, indicated especially by the great increase of the germinal, or *keim*, centers. The feature of unusual interest is the perivascular connective tissue proliferation which continues to increase concentrically about the blood vessels. Phagocytic cells which contain thorium can be seen within the lymph sinuses. A more advanced picture of such changes presents complete loss of the parenchyma, with connective tissue replacement in which the lymph spaces are clearly shown and, at times, dilated. Occasionally masses of phagocytic cells containing thorium show a surrounding encapsulation of connective tissue. At the site of local inoculation, masses of foreign body giant cells, or macrophages, are found, heavily laden with thorium granules.

"The biologic effects produced upon the lymphatic glands visualized by the subcutaneous injection of thorium are unusual in character and differ from those resulting from radium and the x-ray."

Dr. Harris' report indicates that great changes had taken place in the nodes, changes different from those usually seen after irradiation. The inference may be drawn from Dr. Harris' observations that thorium in colloidal form can be the means of normal cell destruction. While no definite proof has yet been shown that the radioactivity of thorium is sufficient to produce such changes, nevertheless we cannot at present disprove such a possibility. Then, again, thorium may exert some unknown destructive effect on normal lymph cells, such as the pathologist reports. In fact, his examination could be interpreted

to mean that the changes brought about in the lymph nodes were so extensive as to render the latter unfit to carry on the usual function of such glands. For this reason, were it possible to produce these changes in metastatic nodules, it would be the equivalent of surgical removal.

Then, again, because it has been shown by Schlundt (8) that thorium dioxide contains both thorium B and thorium D, and that the quantity of these substances in thorium dioxide depends somewhat upon the age of the thorium used in preparing thorium dioxide, the presence of thorium B and thorium D may play an important part in the treatment of cancer. It is well known that they emit characteristic rays which may have biologic effect when suitable roentgen rays are applied to them. It is also possible that the radio-activity of thorium may be shown to have some biologic effect, although Schlundt, in a personal communication, states that his investigation of thorium dioxide is not sufficiently advanced for him to express an opinion as to whether or not the radio-activity of thorium has an appreciable effect from the biologic standpoint.

SUMMARY

In our experiments we were able to visualize lymph nodes and vessels of different animals by subcutaneous, intradermal, and intraperitoneal injections of thorium dioxide. The following lymph nodes and vessels were visualized: popliteal, in-

guinal, mesenteric, axillary, substernal, anterior mediastinal, posterior mediastinal, and intercostal lymph nodes, also lymphatic vessels of the abdominal cavity, the diaphragm, and the thorax.

None of the animals suffered ill effects from the injection of thorium dioxide. The subcutaneous injections did not produce abscess or sloughing, nor even redness or swelling of the skin. We were unable to observe any abnormal behavior of the rats which received intraperitoneal injections. Their appetite and general behavior were normal in every way.

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STIMULATING ACTION OF RADIO-ACTIVE DEPOSITS IN THE BODY¹

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EXPERIMENTS in our laboratory, soon to be reported in the "American Journal of Cancer," indicate that there is no direct stimulation of tissue grown *in vitro* by radium which causes an uncontrolled increase in the rate of mitotic division. Our clinical observations point to some alternative explanation, namely, an over-response by the tissue to a destructive or irritating action. This is consistent with the history of malignancy which developed from an over-exposure among the early radiologists, and is further suggested by the bone necrosis which has been found to occur when radium seeds, improperly screened, have been placed in the oral cavity. This necrosis does not appear as a rule until several years after the exposure. In neither instance is there any radio-active deposit in the body. The action is local and indicates that some element in the cell has been injured, the effect of which does not become apparent for some time. This latent action due to radiation is still unexplained.

The evidence so far produced suggests that the action of radium does not follow the Arndt-Schultz law, namely, that large doses destroy and weak doses irritate. My observations, while growing tissue *in vitro* surrounded by a radio-active medium, leads me to believe that the action of radium is always destructive, that it is a matter of the chance impact of the alpha particle or gamma ray on some vital portion of the cell—probably the nucleus—which causes either the immediate or a delayed death of the cell. The smaller the amount of radio-active deposit present, the less chance there is for this impact to take place within any certain time. This opinion is further strengthened by clinical observations. The same type of destruc-

tion takes place in our cases whether the deposit is large or small, and, furthermore, it becomes just as extensive with the passage of time. The irritation, which may be an etiologic factor in causing malignancy, is the result of the condition of the tissue brought about by the exposure rather than because of the direct irritating action of radium itself.

The first case of radium poisoning that came under my direct supervision was in 1926. It was primarily a case of antral sinusitis and a necrotic involvement of the mandible, ending in general septicemia. In 1924, the patient, while dancing in her home, had suffered a spontaneous fracture of the femur which did not knit. At the time of our examination, the two ends of the fracture overlapped, and were banded together by means of a silver ring. Because of our lack of knowledge, in 1926, as to the action of radium when deposited in the body, we did not believe that there was any connection between the fracture and her industrial exposure. The radiograph of the bone showed no pathologic lesions. At autopsy, no indications of malignancy were found at the area of fracture. It is interesting to note that radiographs of other cases of fractures taken several weeks before failed to reveal any condition that would warn one of such a possibility.

Two years later, another case of jaw necrosis came under my observation and, as an aid to the study, a complete series of radiographs were taken of the entire skeleton by Dr. Joseph Steiner. Radiographs of the skull showed a number of areas of rarefaction—"moth-eaten" in appearance—which made one suspicious of myeloma. The other bones with the exception of the mandible were normal in appearance. The "moth-eaten" areas in

¹ Received for publication, June 29, 1934.



Fig 1 Right femur



Fig 2 Left femur

the skull were found to occur frequently enough as to assume diagnostic value when it was found that the patient had been engaged in dial painting. The areas increase in number and size as the case progresses. It became a routine practice to radiograph the complete skeleton of every case that came under our supervision.

We have had three other cases of spontaneous fractures for study. One occurred in a patient while walking across the floor, and another while the patient stepped down from a chair. The third and most recent one is an impacted fracture of the neck of the left femur which happened when the patient made a misstep while descending the stairs. In none of these cases did a fall precede the fracture.

There was no sign of healing in the first case for over four months. Administration of viosterol was then begun and at the end of six months a solid union took place. Radiographs taken a year later revealed that there had been a spontaneous fracture of one of the ribs, which had healed in the meantime. At the present time, the patient is suffering from ankylosis of the pelvic girdle with areas of rarefaction appearing in the vertebræ and around the pelvic bones. In spite of this deformity, she gave birth to a healthy child this past winter, a Caesarean operation being necessary. When I saw her a few weeks ago, ankylosis was developing around the shoulder girdle and she was unable to raise her arms to her neck. A cataract of

both eyes is gradually developing which leaves her completely blind when out of doors, although within the house with the

firm callus The second fracture, which was proximal and also transverse to the first, had been operated on and plated, the



Fig 3 (left) Exterior side of skull, (right), interior

expanded iris she can still distinguish the number of fingers held in front of her face We have observed this same eye condition in some of our experimental animals

The second case is interesting in that the first fracture occurred in May, 1928, 11 years after the woman had left the industry This healed with callus formation but very little calcium deposit In November, 1929, while moving around the house, she suffered a second fraction above the first in the same femur There has been no evidence of any union taking place at the site of the second fracture In December, 1931, she underwent an operation in an attempt to correct this condition This gave us an opportunity to obtain a biopsy specimen of the bone at the site of fracture for histologic study The gross pathology then noted showed that there had been two different fractures of the femur at different times The lower of these was rather oblique and had healed with slight moderate angulation but with

plate afterwards being removed There had developed at the site of this proximal fragment a pseudo-arthritis with a well defined thick fibrous capsule The bone was distinctly softer than normal, with a cortex about half the normal thickness This was thought to be due in part to disuse, but more particularly to the severe radium poisoning which began about 12 years previous to the observation Up to the Spring of 1934 no callus had formed at the site of the fracture, and recent radiographs show that cracks are beginning to appear in the left femur (Figs 1 and 2) This is the Case No 7 described by Martland (1), in 1931, as presenting a "strong presumptive evidence that sarcoma is developing" Radiographs and a gross examination of the bone in December, 1933, showed no signs of malignancy

We ourselves have had two cases of sarcoma The radiograph readings on these cases before sarcoma appeared are interesting from the view point of our study

Case A There is a symmetrical decalcification and increased calcification of the pelvic bones. The increased calcium is

appear involved. The iliac wings appear to have some diffuse loss of lime salts. The most marked findings are around the left hip joint.

Dr P. C. Swenson is quoted as follows: "This is apparently the second case we have seen which has shown an osteoblastic reaction to radium unless it can be that we are dealing with a possible osteitis deformans. However, this seems a remote possibility." It was from these observations that the study of the stimulating action of radium was suggested.

The doctor in charge of the case was warned in March, 1931, to be on the lookout for sarcoma. He was skeptical at first, but in September of that year, the tumor first became evident and grew rapidly, the patient dying in December, 1931. Autopsy showed that the entire left side of the pelvic cavity was filled with a soft mass which had its origin at the region of the acetabulum. This mass had displaced all the pelvic organs, the bladder and uterus lying against the right pelvic brim. In removing the mass, it was found that the left innominate bone was partially destroyed and very friable, with many jagged points. No evidence of metastases were present. Histologic examination showed the tumor to be myosarcoma.

Four cases of brain tumor have occurred among our patients, and in all of them the "moth-eaten" areas in the skull have been found. In our animal observations practically all of the tumors occur at the site of the fracture. On examination, in cases in which they do not occur at the site of the fracture, the shaft of the bone is found to be pitted and grooved and resembles in gross appearance the lesions found in the skulls. In these instances, the beginnings of tumors are seen in the marrow.

In none of these cases, or in our animal experiments, have we seen any indication of a stimulation of the bone marrow as indicated by an increased number of red cells in a peripheral sample. These are also the findings of Dr. Sabin and her co-workers (2) in rabbit experiments. The



Fig. 4. Photomicrograph of bone destruction in the "moth eaten" areas of the skull.

about the acetabulum and extends upward along the inner half of each iliac bone to the sacro-iliac joints. The eighth dorsal vertebral body is almost completely destroyed, there being an increased calcium content above and below it. Unfortunately, no autopsy could be obtained on this case.

Case B Films of both extremities show a peculiar dense stippling within the cancerous structure of the os calcis and tarsal bone. The right femur shows some thickening of the cortex in the lower and inner aspects which is of questionable significance and probably can be discarded. Films of the shoulder girdles show the same peculiar stippling within the head of the humerus as was noted in the tarsal region. Films of the spine and skull are apparently negative. However, a film of the pelvis shows more of the osteoblastic reaction as previously described in Case A. There seems to be a mixed osteoblastic and osteolytic process along the sacro-iliac regions, the margins of the pelvic brim, both acetabular regions, and also within the left greater trochanter. The pubic bones also

only cases showing a polycythemia of which we have any record were those of four English girls examined for me, in 1925, by Dr A B Rosher, Charing Cross Hospital Medical School. They showed a red blood count, respectively, of 5 60, 4 92, 5 60, 4 98. There might be some question as to whether these figures really indicated a true polycythemia. These girls had worked at dial painting, pointing the brush in their mouths, from one to eight years previous to the examination. However, they showed no ill effects from the occupation, and from the last information we received were still in good health.

HISTOLOGICAL

At autopsy, we were fortunate in obtaining specimens of skull from two cases in which the "moth-eaten" areas were present. Figure 3 shows a radiograph taken of the specimen which had been removed from one of the brain tumor cases.

Case 1. Microscopically, the rarefied areas consist of a loose fibrous connective tissue with only a few small islands of bone. Along the margins of the lesions there is considerable irregularity of the bone, some portions of the margin being rather irregular and others very smooth. The connective tissue is rather acellular. About the blood vessels are seen occasional myeloid foci and lymphocytes, along with scattered hemorrhages.

In this case, the internal surface of the right femur showed a productive exostosis extending about 4 centimeters.

Case 2 (gross). There is a sharply circumscribed lesion about 12×30 mm in diameter within the substance of the bone. It extends through the calvarium except for a narrow strip on the external side about 0.5 mm thick. The internal surface of the skull is slightly depressed at the site of the lesion. This area is very irregular, consisting almost entirely of necrotic bone fragments, and is softer than the surrounding bone.

Microscopically, the section shows fibrous and sometime avascular connective tissue with occasional islands of bone.

Most of the bone is well preserved, but there are many small amorphous islands of bone. The margins of some of the

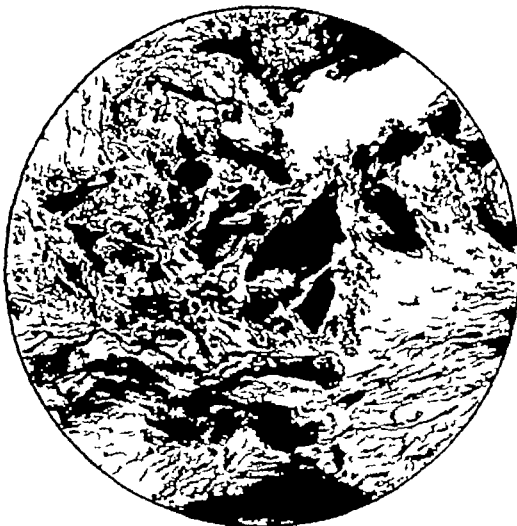


Fig 5 Photomicrograph of bone destruction in the "moth-eaten" areas of the skull

bony trabeculae show much fragmentation, which varies in intensity in different parts of the section. About the necrotic areas, the dense fibrous connective tissue is acellular. Several small hemorrhages and myeloid foci are scattered through the avascular connective tissue. No inflammatory reaction is seen. Figures 4, 5, and 6 show various stages of bone destruction in the "moth-eaten" areas in the skull.

The impression given by these specimens is that some agency locally situated is capable of slowly wearing away the bone tissue that surrounds it, with gradual enlargement of a roughly circular area of bone destruction, followed by replacement with fibrous tissue.

Fracture Case 2. Biopsy specimen removed at operation in a fracture case. The gross specimen is a mass of bone taken from the upper third of the shaft of the femur at the site of the fracture. It is covered on one surface with fibrous tissue, opposite this, is some of the yellow marrow. Starting across from one surface almost to the other is a slit-like separation. The bone

seems hard and dense and shows no evidence of decalcification

Microscopically, the fracture line con-



Fig 6 Photomicrograph of bone destruction in the 'moth-eaten' areas of the skull

sists of dense fibrous connective tissue that joins the bone without any evidence of new bone formation. In places, there is bone necrosis with fragmentation and loss of bone corpuscles. Some of this necrotic bone is being reorganized by new bone formed from osteoblasts. Small areas of osteoclasts are scattered among the fragmented spicules. The marrow shows almost no myeloid elements, in fact, for the most part, it is replaced by connective tissue in which are many new fibroblasts. Some of the blood vessels in the marrow have greatly thickened intima. The bony fragments consist of spicules that hardly show any evidence of new bone formation.

There may be a question in the minds of conservative pathologists as to how many of these findings should be assigned to fracture and how many to the action of radium. But inasmuch as the same lesions can be produced in animals which have been injected with radium, one feels inclined to think that the major portion of the effects are due to the action of the radium deposited in the bone.

DISCUSSION

We have presented our data in detail because we feel that possibly further experiments with radium may lead to some explanation of the occurrence of sarcoma in Paget's disease. Bird (3) has reported five cases in which, he states, a sarcoma has arisen in bone involved in osteitis deformans. We have had the two cases reported here in which there was perhaps a suggestion of osteitis deformans. Our work does not lead to a conclusion that the tumors in the radium cases are caused by direct stimulation, but rather to some specific bone condition which may produce an irritation resulting in an over-response of the organism.

To understand or to get a picture of the action of the radio-active deposits in the body, one must bear in mind certain facts. When the tissue is exposed to radium externally, it is subjected, if the radium is properly screened, only to the gamma ray and not to the alpha and beta particles. The gamma ray of radium has a shorter wave length and is harder than the x-ray. It has been stated that it takes 26.5 cm of soft tissue to absorb one-half of the gamma ray, while 4.9 cm will absorb one-half of the x-ray. However, when radium is deposited in the body, the surrounding tissue is subjected to all three rays, but, because the quantity of radium present in any locality is minute, the action of the gamma ray and beta particle is probably negligible when compared to that of the alpha particle—95 per cent of the rays given off by radium are alpha particles. It has been estimated that 148 million alpha particles are given off per second for each milligram of radium present. It requires, according to the calculation of Swann (4), the impact of only one alpha particle on the nucleus of a cell to kill that cell, but fortunately most of the alpha particles escape into the blood stream in the form of emanations and are eliminated by means of the lungs. Probably 98 per cent of the particles escape in this manner. However, when the bone cell is hit by an alpha parti-

cle and killed, the calcium is absorbed, and finally an area of these absorbed cells is replaced by a fibrous process, as indicated by our histologic sections. The immediate surrounding tissue is devitalized, which accounts for the difficulty, if not impossibility, of stopping the necrotic process of the mandible so frequently present in the radium cases. It also explains the danger of any surgical intervention, as it simply opens the way for bacterial invasion with no healthy tissue to combat it. It is this factor which shows the difference between these cases and the jaw conditions in phosphorus poisoning, which it closely resembles in its gross appearance, and also explains why a sequestrum forms when local damage is done in treating conditions in the oral cavity with radium.

The process is slow in most cases and we have never found an increased calcium content in the blood. In the case of the girls, it may be of interest to note that they found relief from pain by taking calcium gluconate in preference to narcotics.

The association between radium and calcium is further indicated by a case of myositis ossificans progressive, in which I was asked to inject radium chloride. The patient was kept on a low calcium diet and the calcium excretion was determined for several weeks before the treatment began. After the injection of radium salts, an increased calcium elimination took place which decreased as the radium was eliminated. The progression has apparently stopped, as radiographs taken during the past three years (the last set just a few weeks ago) show no increase in calcification of the tissues. The question as to whether there has been any decrease in the calcium deposits is perhaps more difficult to determine, although there is more free movement of the limbs.

Further indication as to the devitalized condition of the cells in the skeleton is shown in the case of pregnant women who have worked at radium dial painting. Patients who showed no sign of decalcification previous to this condition, became crippled, and areas of decalcification

showed up rapidly after childbirth. No matter what treatment is given, it is impossible to get calcium redeposited, and the patient drifts into a more and more crippled condition. One case which I have recently seen is that of a girl whom I have watched for over nine years. At no time have I or anyone else who has been interested in the case, been able to detect more than 0.8 of a microgram of radioactivity in her body; a very small amount to have caused the damage. At the last examination she was apparently negative. She was married about four years ago, and has borne two healthy children. She is now crippled and radiographs of her skeleton show the "moth-eaten" areas we have found in so many of our cases. Rarefaction can be seen in other areas. It might be difficult to say definitely that she is a radium case, however, one cannot help but feel that she ought to be placed, at least, on the suspicious list.

Radium deposits in the body apparently have no effect on the germ cell, as healthy children are borne by these girls and there have been no abortions so far as I have been able to determine by questioning them or their doctors. The birth rate is normal. I have examined some of these children for radioactivity and in some cases have found them to be active. But it is always in cases in which the mother had ingested radium salts during the time she was carrying the child, or before the salt had been more or less mobilized in the skeleton. If the mother has been away from the industry for a year or so before becoming pregnant there is no sign of activity. I have been unable to keep track of all of these active children, but blood samples taken at the time of examination showed a tendency toward anemia.

All of the evidence given in this paper points to a destructive action of radium rather than to a stimulating one. All of our cases of sarcoma and those reported by Martland (many of which I have been privileged to test for radioactivity) contained less than 20 micrograms of radium, most of them, I believe, testing nearer ten

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Fig 6 Photomicrograph of bone destruction in the "moth eaten" areas of the skull

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To understand or to get a picture of the action of the radio-active deposits in the body, one must bear in mind certain facts. When the tissue is exposed to radium externally, it is subjected, if the radium is properly screened, only to the gamma ray and not to the alpha and beta particles. The gamma ray of radium has a shorter wave length and is harder than the x-ray. It has been stated that it takes 26.5 cm of soft tissue to absorb one-half of the gamma ray, while 4.9 cm will absorb one-half of the x-ray. However, when radium is deposited in the body, the surrounding tissue is subjected to all three rays, but, because the quantity of radium present in any locality is minute, the action of the gamma ray and beta particle is probably negligible when compared to that of the alpha particle—95 per cent of the rays given off by radium are alpha particles. It has been estimated that 148 million alpha particles are given off per second for each milligram of radium present. It requires, according to the calculation of Swann (4), the impact of only one alpha particle on the nucleus of a cell to kill that cell, but fortunately most of the alpha particles escape into the blood stream in the form of emanations and are eliminated by means of the lungs. Probably 98 per cent of the particles escape in this manner. However, when the bone cell is hit by an alpha parti-



Fig 6 Photomicrograph of bone destruction in the 'moth-eaten' areas of the skull

sists of dense fibrous connective tissue that joins the bone without any evidence of new bone formation. In places, there is bone necrosis with fragmentation and loss of bone corpuscles. Some of this necrotic bone is being reorganized by new bone formed from osteoblasts. Small areas of osteoclasts are scattered among the fragmented spicules. The marrow shows almost no myeloid elements, in fact, for the most part, it is replaced by connective tissue in which are many new fibroblasts. Some of the blood vessels in the marrow have greatly thickened intima. The bony fragments consist of spicules that hardly show any evidence of new bone formation.

There may be a question in the minds of conservative pathologists as to how many of these findings should be assigned to fracture and how many to the action of radium. But inasmuch as the same lesions can be produced in animals which have been injected with radium, one feels inclined to think that the major portion of the effects are due to the action of the radium deposited in the bone.

PROTRACTED EXTERNAL IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE MOUTH AND THROAT

A COMPARISON BETWEEN X-RAYS, FIVE-GRAM PACK, AND SMALL RADIUM PACK¹

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THIS presentation is a preliminary report of clinical and laboratory work done in a further attempt to determine the comparative clinical values of radium and x-rays. The work was carried out in the Radiation Therapy Division of Bellevue Hospital as part of the regular therapeutic service of the Cancer Division, and with the assistance of a fellowship established through the courtesy of William R Warner & Company, and Schering & Glatz.

Three distinct methods of irradiation were employed: high voltage x-rays generated at 200 K V, a small 100-miligram radium pack, and a 5-gram pack. The latter radium was loaned to Bellevue Hospital by Radium Belge.

The physical measurements and experiments were carried out with special apparatus designed for this work, and the physical problems associated with this study were worked out by one of us (C B B).

PURPOSE OF THE WORK

Two years ago, there were reported simultaneously two techniques for treating neoplasms of the mouth and throat: one by Coutard, who advocated protracted external x-ray radiation, and one by Berven, who advocated protracted external radium radiation followed by endothermic incision and interstitial radiation. Berven said that empirical experience confirmed in his own and his co-worker's minds the superiority of radium over x-rays. Coutard did not specifically compare the two types of rays, but indicated in his report remarkable successes in the treatment

of pharyngeal, tonsillar, and laryngeal malignancies with x-rays, but did not offer a basis for clinical comparison because of the wide differences in technique. The lesions Berven treated were mainly of the radioresistant intra-oral types, and the external radiation was followed by endothermy and interstitial radiation. Those conditions treated by Coutard were the more radiosensitive lesions of the tonsil and hypopharynx, with the exception of the more resistant laryngeal growths. His cases were treated exclusively by external x-ray radiation. Nevertheless, each employed a ray of characteristic physical qualities which produced specific physical and biological effects.

Experimental radiotherapy is currently directed toward the application of rays of shorter effective wave length than those produced at 200 K V and 0.5 mm copper filtration. By increasing the filter to 2 mm copper (as employed by Coutard), the wave length is shortened from approximately 0.16 Ångström to 0.11 Ångström. With the application of gamma rays, wave lengths of the order of 0.01 Ångström are used. In order to produce these with the x-ray tube, a potential of more than a million volts would be required.

The laboratory's contribution to the study of the influence of wave length upon biological effect has been to present conflicting evidence. Packard exposed eggs of the *Drosophila melanogaster* to x-rays produced by potentials ranging from 12 to 500 K V, with respective wave lengths of 1.7 to 0.02 Ångström. With the same number of r administered in the same period of time, he found no difference in the inhibitory powers of these rays on the various eggs.

¹ Read at the American Congress of Radiology at Chicago Sept 25-30 1933.

For this reason, the destructive action is slow, a pathologic condition of the bone increasing with time. In most of the cases, I believe one can say that the sarcomas have appeared in the areas carrying the greatest stress.

This supervision consists of providing the proper medical and dental care, as well as compensation for practically all cases outside of New Jersey.

I wish to acknowledge my indebtedness to the many radiologists and other medical men who have lent me their assistance in this study, as well as to the Josiah Macy

Foundation who furnished funds which permitted the clearing up of certain points.

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urements Part of the work, "The Effect of Filtration and Distance upon Depth Dose," has been presented in a previous paper by Braestrup. A complete description of the physical investigation will appear in a subsequent paper now in preparation. For the present, we shall limit ourselves to a discussion of the results of the physical measurements as summarized (See Table II).

It will be observed that here are included not only the forms of irradiation used in the present clinical investigation but also the more common technics. This serves to illustrate the fundamental physical difference between the Coutard method and the usual forms of high voltage x-ray therapy.

By changing from 0.5 mm of copper filtration to 2 mm of copper the effective wave length is materially shortened by further elimination of the longer components of the x-ray spectrum. The half value layer is almost doubled, with a resulting improvement in depth dose of 3 per cent, while the increase in focal skin distance from 50 cm to 60 cm caused a 2 per cent depth dose gain in terms of the surface dose, making a total gain of 5 per cent in the depth dose. In terms of the depth intensity, the improvement is about 14 per cent by changing both filter and focal skin distance. However, to obtain these improvements in quality and depth dosage 75 per cent of the intensity is sacrificed, which must be compensated for by increasing the time.

Of particular interest is the small depth dose obtained with the radium pack. This, of course, is due to the short radium skin distance and, to a lesser extent, to the smaller field. A 6-cm distance was selected for economical reasons, as well as to duplicate the technic used at Radiumhemmet.

The radium intensity of the radium pack was determined indirectly by photometric comparisons with a point source of known radium content. By this method errors due to the stray radiation from the pack were eliminated. The result indicated may be subject to minor corrections due to the wave length dependence of the thimble chambers used. It was found that in one hour, 480 r were given (about 8 r/min). The clinical erythema dose administered in three and one-half hours was produced by 1,680 r.

TIME OF TREATMENT

The total irradiation was administered within a period of from 21 to 28 days. This period of time was selected for many reasons. First, when a full skin erythema dose is given in one sitting, with x-rays at 200 K V, and with 2 mm copper filtration, the erythema commences to subside on the twenty-first day. This is indicative of the destructive phase of the treatment, and the ascension of the healing phase. Associated with the healing phase, there occurs fibrosis and increased radio-resistance. It has, therefore, been necessary

TABLE II

Physical factors. The first section indicates the character of the x rays, filtered with 0.5 mm copper. This ray, which has been employed in the older technics, is described here for purposes of comparison.

Roentgen Rays Produced at 200 K V —4 ma (puls. pot.)					Gamma Rays 5 gram radium pack
Filtration	0.5 mm Cu + 1 mm Al	2 mm Cu + 1 mm Al			0.5 mm Pt + 5 mm Pb
Field	10 × 15 cm	10 × 15 cm			8 × 10 cm
Distance	50 cm	60 cm	50 cm	60 cm	6 cm
Intensity (in air)	13.2 r/min	9.1 r/min	4.96 r/min	3.44 r/min	7.94 r/min
Quality H V L	0.92 mm Cu	1.8 mm Cu			12.5 mm Pb
Wavelength	0.16 Å	0.11 Å			0.01 Å
Depth Dose 5 cm	65.4 per cent	67.9 per cent	67.0 per cent	69.6 per cent	26.5 per cent
10 cm	34.9 per cent	37.1 per cent	37.9 per cent	40.2 per cent	12.0 per cent

Recently, Glasser and Mautz have disagreed with Packard's conclusions by demonstrating their own inability to standardize the *Drosophila* eggs. However, they deemed this medium suitable for approximate comparative measurements of the effectiveness of gamma and x-rays, and in their tests, conclude that different wave lengths produce different effects. Failla and his co-workers find that gamma rays are several times more destructive to *Drosophila* eggs than x-rays (200 K V, and 0.5 mm Cu filtration).

From these and other conflicting laboratory reports, it is impossible at the present time to draw any final conclusions.

PROCEDURE

We have attempted to study the problem of the influence of the wave length on the biological effect clinically. There were selected for treatment only those patients suffering from cancer of the mouth and throat. These cases offered for study three kinds of tissues of varying radiosensitivity: the skin, the mucous membrane, and the tumor itself, all of which could be continuously observed.

The three types of rays employed are produced with the following factors (See Table I):

1 *X-rays (Coutard Technic)*—K V 200, 4 ma, 2 mm Cu and 1 mm Al filtration, 60 cm distance, 10 × 15 cm portal (150 sq cm), duration of treatment, 21 to 30 days, time of each treatment, 40 minutes (average), two areas treated each day—one in the morning and one in the afternoon, total dose, 6,800 to 8,800 r ($3\frac{3}{4}$ S E D to 5 S E D to each area).




2 *Five-gram Radium Pack*—Six mm lead filtration, 6 cm distance, 8 × 10 cm portal (80 sq cm), daily dose, 5,000 to 7,500 mgm-hrs (only one area treated each day), total dose, 50,000 mgm-hrs (3 S E D) to 60,000 mgm-hrs ($3\frac{1}{2}$ S E D) to each area, when two areas are treated, 35,000 mgm-hrs (2 S E D) to 45,000 mgm-hrs ($2\frac{3}{4}$ S E D) to each area, when three areas are treated, grand totals, 100,000 mgm-hrs to 135,000 mgm-hrs.

3 *Small Radium Pack*—100 Mgm—Five mm lead filtration, 6 cm distance, 6 × 8 cm portal (48 sq cm), time, 21 to 25 days, dose, 50,000 to 60,000 mgm-hrs to only one area.

PHYSICAL MEASUREMENTS

The physical factors of the different forms of irradiation were determined photometrically as well as by ionization meas-

TABLE I—TECHNICS EMPLOYED

	X-rays	Large Radium Pack	Small Radium Pack
	 200 K V 4 ma	 5 000 mgm	 100 mgm
Filtration	2 mm Cu and 1 mm Al	$\frac{1}{2}$ mm Pt and 5 mm Pb (6 mm lead equivalent)	$\frac{1}{2}$ mm Pt (5 mm lead equivalent)
Distance	60 cm	6 cm	6 cm
Portal	10 × 15 cm (150 sq cm)	8 × 10 cm (80 sq cm)	6 × 8 cm (48 sq cm)
Daily dose	200–250 r to each of two portals	5 000–7 500 mgm-hrs to one area each day	2 400 mgm-hrs to only one area
Duration	21–30 days	25–35 days	21–25 days
Total dose	6 800–8 800 r to two portals ($3\frac{3}{4}$ –5 S E D)	50 000 (3 S E D)–60 000 ($3\frac{1}{2}$ S E D) mgm-hrs when 2 areas are treated 35 000 (2 S E D)–45 000 ($2\frac{1}{2}$ S E D) mgm-hrs when 3 areas are treated Grand total 100 000–135 000 mgm-hrs	50 000–60 000 mgm-hrs to one area

ance of 6 cm, the threshold skin erythema dose was found to be 17,500 milligram-hours. The duration of each daily treatment of

in a busy clinic, many of whom were not very co-operative, has made it difficult to secure a standard time duration for the

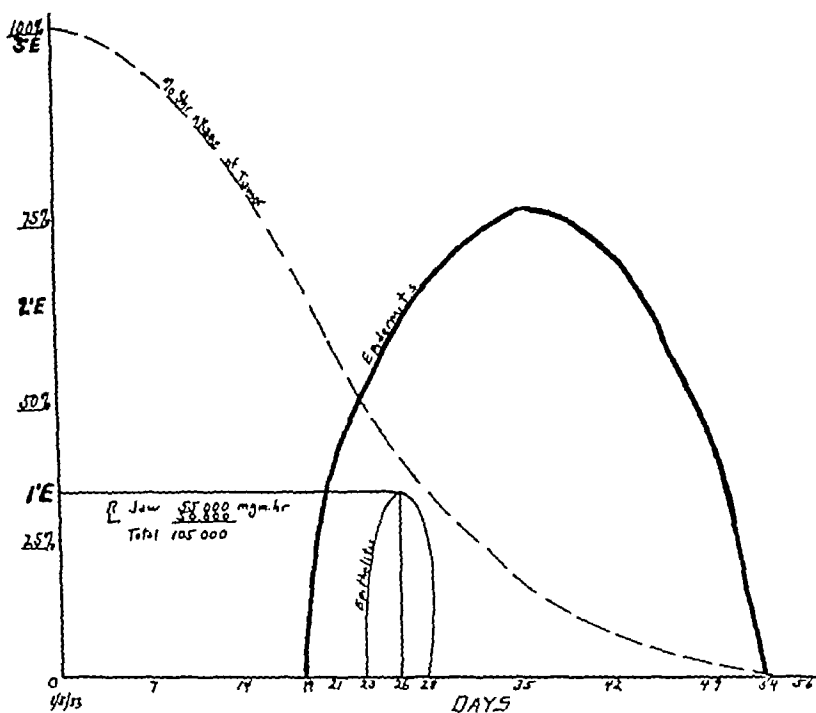


Fig 2 Typical graph of clinical factors indicating time of treatment and intensity of epithelitis and epidermitis. This graph is constructed during the course of the treatments, entries being made weekly

5,000 mgm-hrs was one hour, and was equivalent to 30 per cent SED daily. Only one of the two areas was treated each day, giving an average of 2,500 mgm-hrs to one area each day, as compared with 2,400-mgm-hrs to one area each day given by the small pack. When three areas were used, the daily dose was raised to 7,500 mgm-hrs in order to maintain this same daily average per field (Fig 3-E).

In order to maintain close parallels in the various technics, we strove to employ the exclusive technic of protracted external radiation, thereby differing from Berven's technic in that interstitial radiation was not to be an integral part of the routine. Interstitial radiation and endothermic surgery were employed only in the event of a proved or anticipated failure. The necessity for treating a large number of patients

treatments. Because of complicating outside conditions, treatments were delayed in many instances, so that the average time for administering radium pack treatments has been 28 days as against 21 days for the Coutard technic.

Though this has made it difficult for accurate comparisons, it proved to be a happy accident. In a single skin test with the radium pack, the erythema appeared on the fourteenth day, and lasted for 14 days before it began to subside. The resolution of the destructive effect and the commencement of the healing phase from this exposure occurred on the twenty-eighth day. Thus all the radium pack treatments had been administered before fibrosis and increased radio resistance had set in. In this period of 28 days, it required an average of 110,000 mgm-hrs total dose, or 55,000

to administer all treatments before this occurred. Second, when a proper series of treatments has been administered accord-

mal tissues, and is followed by persistent epilation and other skin changes, destruction of the salivary gland function, osteitis

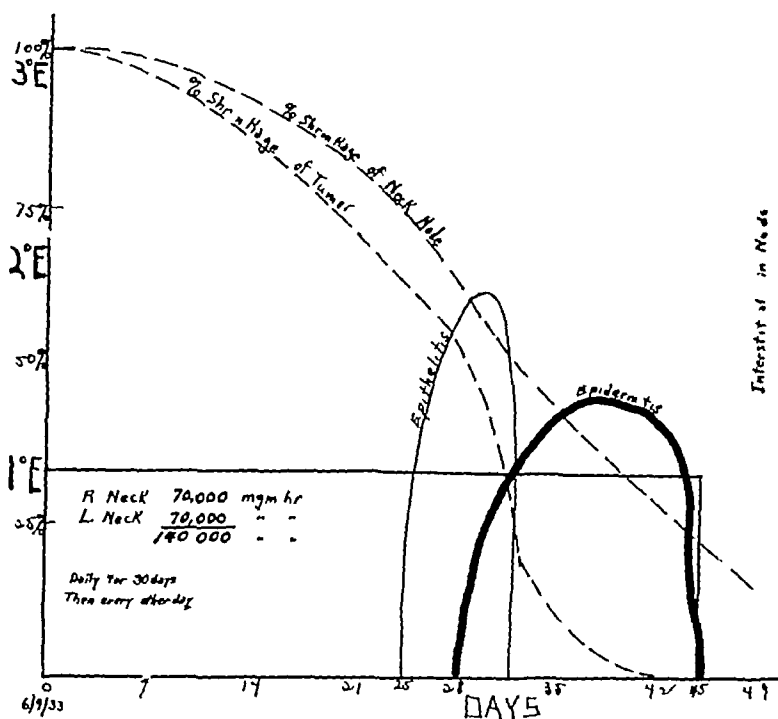


Fig 1 This chart illustrates the inefficiency of treatments administered over too long a period of time. There is healing of the epithelitis and epidermitis even while the treatments are being administered. It also demonstrates the greater resistance of the neck nodes in comparison with the local lesion, even though their superficial location permits a greater depth dose.

ing to the exact Coutard technic, our experiences indicate that the average epithelitis first appears on the fourteenth to the sixteenth day, and commences to subside on the twenty-first day *even though treatments were being administered currently* (See Fig 1). Thus there is noted a healing process of the mucosa even during the administration of the destructive rays. Third, our experiences coincide with those of Coutard, *i e*, if the duration of the treatments is shortened too much, there results an increase in the severity of the epithelitis and epidermitis, with a prolongation of these reactions. This necessitates a curtailment of the total dose administered. This prolonged reaction is significant of the excessive destructive effect upon the nor-

of the mandible, and continuous dry sore throat.

THE FIVE-GRAM RADIUM PACK

At the beginning of our work, we expected that when heavily filtered gamma irradiation was administered to the patient in such large doses as to produce in the same period of time equivalent biological reactions of epithelitis and epidermitis up to the point of lethal tolerance of the tissues, it would prove much more destructive to the tumor than x-rays through a greater selective action, due perhaps to the more intense Compton effect. This thought led to the construction of the 5-gram radium pack. Using a filter equivalent to 6 mm lead, and an 8 X 10 cm portal, at a dis-

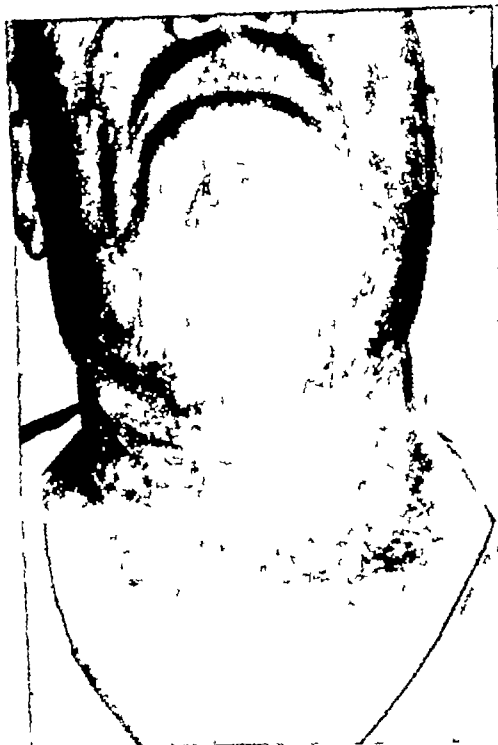


Fig 3-C Case 1 Skin of neck on thirty sixth day, showing reaction at its height



Fig 3-D Roentgenogram of larynx before treatment

to be compelled subsequently to curtail the total quantity of radiation administered because of a too intense reaction in the oral mucosa

General reactions from radiation were treated with Mead's viosterol

SUBSEQUENT TREATMENT

Protracted external radium irradiation exhibits a profound effect upon the normal as well as the neoplastic tissues. This is particularly evident when interstitial radiation is employed. Residual tumor tissue subsequently treated by interstitial radiation may be completely destroyed and the surrounding area of healthy tissue, because of its fibrosed condition from the external radiation effect, will break down immediately or else a month or two later, and produce, along with the ever-present infection in the mouth, a rather intensive septic ulceration. This infected ulcer may last for months and, in time, may even produce generalized metastatic lesions of

chronic sepsis. A mild radium osteitis may occur in adjacent bones, usually the mandible, so that further interstitial radiation or topical application of radium may cause an osteomyelitis which is more persistent and pernicious than that formerly seen. When such a condition is likely to occur, Berven's procedure of endothermic excision and interstitial radiation is carried out, except in a reverse order. It is our opinion that interstitial irradiation, even in small doses, of normal tissues already heavily irradiated from without prolongs the healing time and leaves a persistent, painful, infected ulcer. For this reason, we administer the interstitial radiation immediately after the acute reaction from the external irradiation has subsided. After an interval of one week, in order to permit some fibrous reaction of the tumor bed to take place, the tumor-bearing area is excised.

This excision must not only clean up the slough, but must also radically extirpate

mgm-hrs to each of two areas to produce a second degree erythema with superficial denudation of the epithelium (Figs 2 and

erythema, and frequently becoming infected and forming abscesses. A late conjunctivitis with lacrimation, epilation

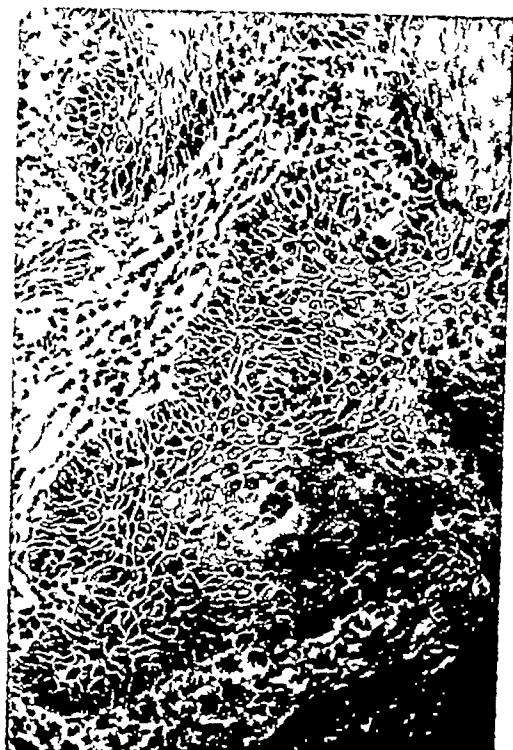


Fig 3-A Photomicrograph of tissue, Case 1 intrinsic carcinoma of the larynx, histologic Grade I. Patient was well ten months after the beginning of treatments

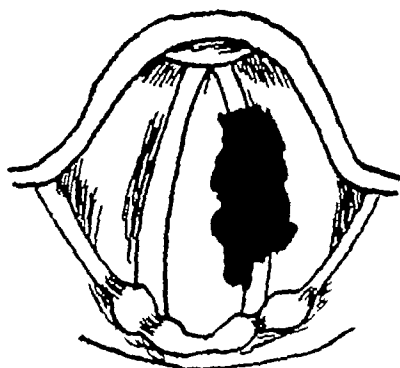


Fig 3-B Diagram of initial lesion Case 1

3-E) The average duration of the epidermitis from such a dose was 32 days. The accompanying epithelitis was less intense than that produced by x-rays. However, when the gamma radiation was administered within 14 days, the epithelitis was of equal intensity to that produced by x-rays given in the same short period of time.

Because the gamma-ray beam is accurately delineated by the lead wall of the pack, the epilation is much less extensive than that produced by the small pack, in cases in which there is no protecting confinement of the gamma-ray beam. In addition, there were noticed other external reactions, such as multiple small sebaceous cysts, caused by the plugging of the necks of the ducts with desquamating epithelium associated with the severe second degree

of the eyebrows and eyelashes, and marked photophobia requiring several months to abate may occur if the carcinoma is located on the roof of the mouth, in the nose, or sinuses, so that the high-placed beam of treatment rays includes the eyes in its path.

When the pack treatments are administered over a longer period of time than usual, which occurs when the patient is unco-operative and does not keep his appointments (a frequent incident among the ignorant poor with whom we have to deal), and a compensatingly larger dose is given, the mucosal reactions are not very intense, but the skin reactions extend over a much longer period of time, lasting sometimes as long as 60 days.

The intensity of the epithelitis is occasionally variable, when employing the same technic on similar cases, as a result of pyorrhea, misaligned and sharp-edged teeth. This is frequently seen as areas of excessively severe second degree epithelitis with denudation in a horizontal line on only those parts of the buccal mucosa which come in contact with the bad teeth. Therefore, we have concluded that it is wiser to delay the onset of treatment for from two to three weeks until mouth hygiene has been completed, rather than

THE SMALL RADIUM PACK

The pack itself consisted of a hollow wooden box, 6 × 8 cm square and 5 cm

skin reaction and curtails the total dose permitted

The treatment was administered in from 21 to 25 days, the dose varying between

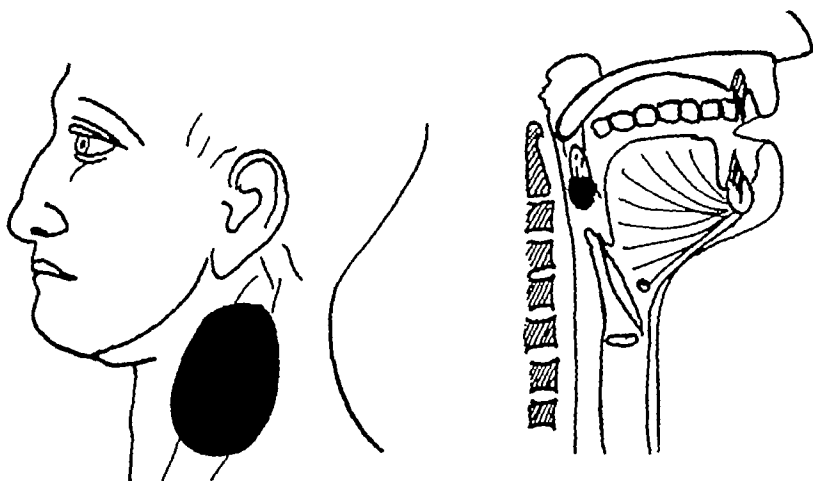


Fig 4-A Case 2 Carcinoma of pharynx (diagrammatic sketch)

high, to the top of which the radium was strapped. One centimeter additional compressed absorbent cotton was placed next to the skin, increasing the distance to 6 centimeters. This cotton avoids the compression necrosis which may appear during the last week of the treatment and which frequently aggravates the intensity of the 50,000 and 60,000 mgm-hrs over one area. Because of its form, an insufficient protection of the patient against scattered rays was afforded, and therefore the pack was applied only to one side of the neck (See Fig 4-F).

The reactions to this form of treatment showed a fair degree of constancy. The epithelitis, which commenced about the seventeenth day, endured almost ten days. It was usually second degree in nature, being accompanied by soreness, redness, denuded areas in the mucosa, and fibrinous radium membranes. It was more intense in the mouth than in the throat, being aggravated by irritation of sharp teeth and pyorrhea. In many instances, focal areas of denudation of the mucosa could be seen around single teeth which were

either badly infected and decayed or else angulated so as to cut into the cheek. The fibrinous membranes would remain present for from 3 to 5 days and then rapidly disappear. Throughout the whole course of the treatment, the patient was seldom very uncomfortable from this reaction.



Fig 1 B Case 2 Mass in neck before treatment

the entire tumor-bearing area, a wide margin of heavily irradiated normal tissue, and all the infected bone down to the healthy

of this radiation has been administered, the tumor has not shrunk more than 50 per cent (a figure adopted empirically,

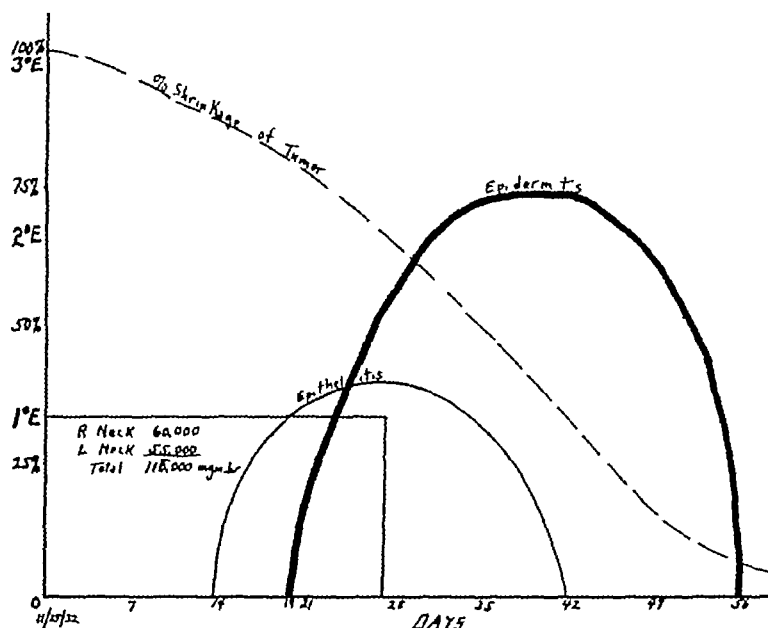


Fig 3-E Case 1 Treatment chart (Five gram pack, 0.5 mm, Pt + 5 mm Pb filter, 6 cm distance 8 X 10 cm portal)

bone, even though partial resection of the mandible or maxilla may be necessary. This extensive post-radiation débridement and resection not only shortens the time of debility due to a prolonged radiation reaction, but contributes greatly to the eventual cure. Paradoxically, the more extensive the resection is, the quicker will the defect heal, and *vice versa*. From experience, we have learned of the inevitability of this resection. A persistent tumor which is irradiated interstitially is going to require endothermic excision sooner or later. If, by chance, it should heal spontaneously following interstitial radiation, it becomes fertile with complications, such as severe pain, recurrent necrosis, limitation of motion and function, and sepsis, all leading to a general debility of the patient and susceptibility to intercurrent infection.

To summarize the routine of radium treatment. First, protracted intensive external radiation. If, after two-thirds

and subject to change as experience dictates), then external radiation is immediately terminated and interstitial radiation carried out. This lesser amount of external radiation permits the tumor bed to react better to the subsequent interstitial radiation, and minimizes the debility from a painful epithelitis and epidermitis. One week after this interstitial radiation, if the patient's general condition permits, and there is no excessive edema and swelling of the tissues within the month, the tumor is excised. If, however, at the termination of the usual course of external radiation, there is a small residuum of tumor tissue, a very small dose of interstitial radiation is given, followed by endothermic excision. If the lesion has disappeared completely as a result of the external radiation, the tumor-bearing area is excised conservatively by endothermy, and no interstitial radiation is given, unless the subsequent microscopic examination reveals the further presence of malignant tissue.

only one portal was able to produce in several instances a profound effect upon resistant tumors with only slight local discomfort to the patient

However, because the large pack has a portal twice the size of the small pack, this difference in reaction is somewhat lessened because the smaller pack confines its intense central radiation beams to a smaller area

X-RAYS

From our clinical observations, we are of the opinion that there is a distinct difference in the effect of x-ray therapy when the filter used is changed from 0.5 mm to 2 mm copper, at 200 K V. The lesser filtration produced a more severe degree of epithelitis with more extensive ulceration of the mucosa and fibrinous membrane formation. The soreness and dryness of the mouth and throat were more prolonged. This excessive reaction diminishes the total amount of radiation that can be administered to the patient. The largest quantity that we administered to any one patient, employing 0.5 mm copper filtration, was 5,500 r, while with 2 mm copper filtration, a total dose of 8,800 r was safely given. Though the number of cases in this group was small, there appeared to be less shrinkage of the lesion itself with the thinner filter. Coutard's preferential adoption of an increased filter indicates a like conclusion as to the biological superiority of the shorter wave length, based on his clinical experiences.

As Braestrup has shown, the greater the penetrability or quality of the ray, the higher the dosage in depth. With each increase in filter thickness, there is, therefore, an improvement in the depth dose. Yet, a point is soon reached where the fractional improvement is small and further increase in the filter thickness is not justified.

It is a known fact that an effective increase in the percentage depth dose can be accomplished, too, by an increase in the focal skin distance. Due, however, to the great increase in the time required to give



Fig 4-E Case 2 Healed skin, showing depigmentation

the same dosage at the longer distances, we have learned that for practical purposes 60 cm is the most applicable distance. This, too, is in accord with the Coutard technique which we have endeavored to duplicate.

In administering the protracted external x-ray therapy according to Coutard's outline, we have attempted no modifications. The factors used were 200 K V, 4 ma, 60 cm distance, 2 mm copper and 1 mm aluminum filtration, 10 × 15 cm portal, daily dose of 200–250 r to each of two portals, total dose 6,800–8,800 r (See Fig 5).

It is a difficult feat to confine all the treatments to a period of approximately twenty-one days, but, with increasing experience, it becomes more evident that the slight variations in the number of days of treatment causes definite changes in the responses of the patient and his tumor. Effective protracted external irradiation constitutes a therapeutic barrage with only one round of ammunition which must be carefully aimed.

In this maze of inconstant biological factors with their innumerable variables, it is astonishing to note, as Coutard so brilliantly indicated, the close relation of the duration of the treatment to the time of onset of the epithelitis and epidermitis. A well-planned course of treatments given in twenty-one days will produce an epithelitis commencing on the eighteenth day, and terminating on the twenty-sixth day, at which time the epidermitis commences



Figs 4-C and 4-D Carcinoma of the hypopharynx, with massive metastatic lymphadenopathy. The small pack is held in place with bandages. Note the healing of the skin in multiple small islands. The epithelitis from the small pack is usually not intense or prolonged. Figure 4-D shows condition on the forty second day. Note epithelization progressing around small islands, also extensive epilation.

The epidermitis occurred with a slightly greater intensity commencing about the twenty-first day, upon the termination of the treatment, and during the middle of the epithelitis, so that the two reactions overlapped. The exact time of onset of the epidermitis was not infrequently confused by the erythema from pressure irritation due to the weight of the pack. The reaction would last from 3 to 4 weeks. At its height, there would be an area of denudation about 7 cm. in diameter, which healed in one week from multiple small islands in the center, indicating that the destruction had involved only the superficial epidermis, and not the germinal layer. There would be an extensive area of epilation of the hair of one side of the head, and a conjunctivitis and occasionally epilation of eyelids. This was due to the insufficient lead protection around the pack, which had to be of light weight in order that the patient might carry it around comfortably for the required twenty-one days. Following the treatment, the skin healed and became soft and

normal except for an occasional area of depigmentation.

While the stray radiation of the small pack made it inadvisable to apply it to more than one area, the large 5-gram pack with its heavily protected walls was readily applicable for treating two and occasionally three areas. In a few instances, however, the 5-gram pack was applied to only one portal, and it is from these reactions that we offer a tentative comparison of the nature of the cutaneous and mucosal reactions, but none concerning the effect on the tumor itself between this form of treatment and that of the small pack. On the basis of the evidence thus obtained, we are of the opinion that cutaneous 24-hour daily irradiation for from 21 to 25 days, up to a total of 50,000 mgm.-hrs with the small pack, will produce an epithelitis and epidermitis equal to a dose of 60,000 mgm.-hrs produced with the large pack given in units of one hour per day during the same period of time. Furthermore, the small pack with a total dose of 50,000 mgm.-hrs directed through

coincident attenuation of the virulence of the neoplasm with an increased radio-resistance. Increasing the total dose much

CONCLUSIONS

- 1 In employing x-rays and gamma rays

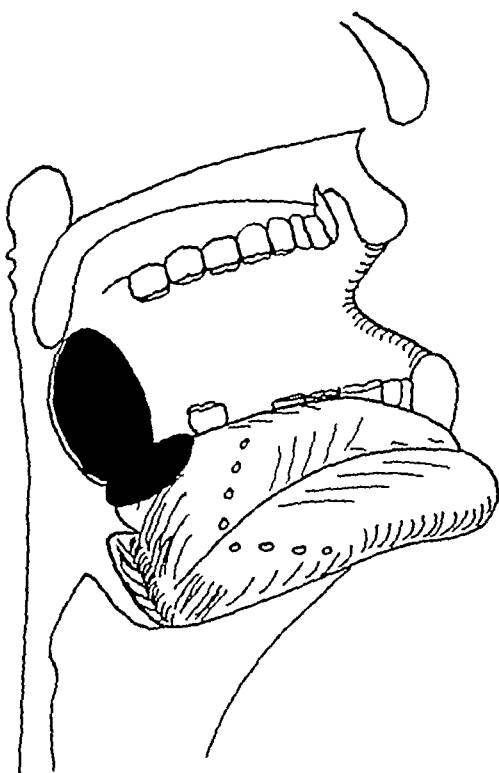


Fig 5-A Case 3 Drawing showing location of cancer of the tonsil

above 8,000 r serves very little to intensify these reactions or the effect upon the tumor. It is consequently, in our opinion, of great importance to avoid extending the treatments into the healing phase.

In comparing the effect of the x-rays with the gamma rays, we were surprised to note the similarity in action of these two rays on the skin and mucosa. The number of cases are too few to permit comparison of their effects on the tumor, but to date, there appears to be no appreciable difference. Interstitial radiation following x-ray therapy is more comfortably tolerated by the patient and the local tumor bed, there being less pain, fewer sloughs, and less intense bone complications.



Fig 5-B Carcinoma of the tonsil treated with the Coutard technic. Skin reaction was not very severe, due to the low total dose. Interstitial radiation was well borne. The photograph shows the reaction at its height (32 days).

in a manner similar to the techniques outlined by Coutard and Berven, respectively, we find that early observations indicate a similarity in their effect upon the tumor.

This seems to indicate that the shorter wave length of the gamma rays compensates in effectiveness for the relatively low depth dose obtained with the radium pack at 6 cm distance. In order to take advantage of any superiority of the radium pack, it will be necessary for us to increase the treatment distance considerably above 6 cm in order to improve the depth dose. The benefit to be derived from this step may justify its increased cost.

2 The duration of the period of administration of treatment is the most important factor in protracted external irradiation. Each type of neoplasm has its own rhythm of response which must be paralleled by an optimum time duration of the treatments. Furthermore, each type of radiation has a characteristic period of greatest effectiveness, during which the destructive phase is in the ascendancy and the healing phase has not yet commenced. The proper delicate adjustment of these two factors is essential to efficient protracted radiation.

If the treatments are administered in a shorter period of time, the two reactions overlap. If given over a longer period of treatment is one that will produce consecutive reactions, the epidermitis commencing as soon as the epithelitis has subsided.

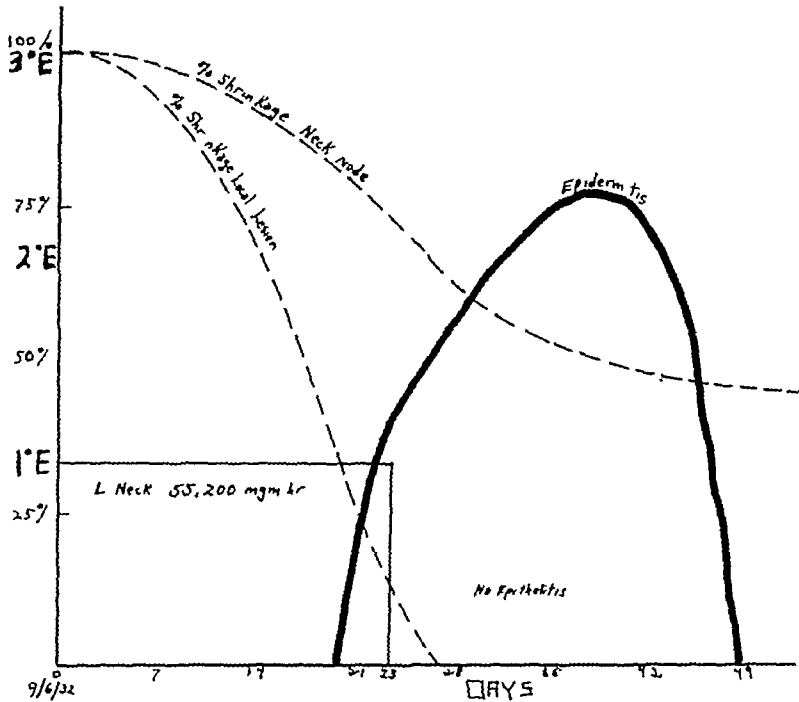


Fig 4-F Chart of Case 2 Technic 100 mgm radium pack, 6 cm distance, 2.5 mm Pt filter 6 X 8 cm portal

time, the epithelitis and epidermitis are of lesser intensity and are separated by a definite time interval. Increasing the total dose, as we have done on occasion, above 8,000 r when the treatments had been unavoidably dragged beyond twenty-one days, does not seem to influence the character of the reactions or the response of the tumor. Our experiences and those of Coutard confirm this theory, especially when applied to the administration of a second series of external x-ray treatments. Consequently, we do not recommend this repetition except where no alternate therapy is available, such as in carcinoma of the larynx. In a carcinoma of the tonsil, however, we have found a second series of external irradiation with x-rays much less effective than interstitial radiation and endothermic surgery.

Coutard says that the best regulated

Our best effects were secured in those cases in which there was an overlapping of the reactions for a period of from 5 to 7 days. If the treatments are given over too long a period of time, i.e., from 30 to 35 days, the reactions are late in appearing, the epithelitis usually healing, and then, after an interval of a few days, the epidermitis appearing. The soreness from the epithelitis was mild and frequently did not appear. The skin reaction was not very severe. This sparing of the patient and the hurdling of the obstacle of intense debility of the patient during the time of the reaction deludes one into choosing the prolonged schedule of treatments, but it should be remembered that the mildness of the reactions and their tardiness in appearing may be due to the increased resistance of the tissues as a result of the desmoplasia of the healing phase. There is a

xtends for three-fourths of a centimeter
o the base of the tongue, and is not very
inct from the surrounding tissues
he history as taken Sept 6, 1932, is as
ows The onset occurred seven weeks

to measure $2 \times 2 \times 2.5$ centimeters
Eleven radon seeds were inserted, the
dose given was 2,783 millicurie-hours

Progress was as follows Subsequently,
in the same area several new nodes ap-

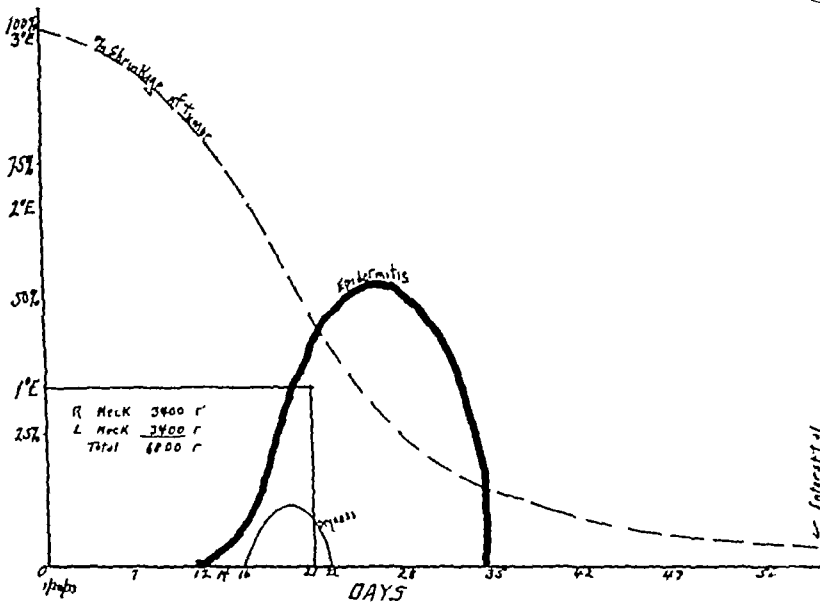


Fig 5-D Chart of Case 3 Technic 200 K V 4 ma 2 mm Cu, 60 cm distance

Previously, with a small node in the left
neck which has grown larger

The histological examination as taken on
Aug 24, 1932, is as follows A plexiform
epithelioma of the spindle-cell type

External radiation was given as is shown
in Chart 4-F

The reaction was as follows The throat
was very comfortable, no epithelitis The
local lesion healed on the twenty-seventh
day The large neck node increased the
distance of the radium from the lesion by 3
cm, which may have accounted somewhat
for the absent epithelitis There was
second degree epidermitis, denudation
did not involve the germinal layer of the
epithelium, healing occurred from multiple
islands of regeneration (Fig 4-D)

Interstitial radiation was given on Jan
12, 1933, the one hundred and thirty-sixth
day Under local anesthesia, the neck
node was exposed by an incision and found

peared which did not respond to further
treatment (See Figs 4-A to 4-F)

The patient died on June 7, 1933

Cancer of the Tonsil—Case 3 The history
as taken on Jan 20, 1933, is as follows A sore throat started one month
previously, at present, there is pain on
swallowing and slight fixation of the
tongue

Examination shows the following Over
the left tonsil there is a flat growth which
covers it entirely, and extends on to the
left posterior border of the tongue The
tonsillar part measures $2.5 \times 3 \times 0.5$
centimeters It is the same color as the
surrounding tissues, and is very hard
The left glossotonsillar groove is obliter-
ated The extension on the tongue meas-
ures $2.5 \times 2.5 \times 0.5$ centimeters The
lower border of this part is 0.5 cm above
the tip of the epiglottis The patient's
age was 59 years

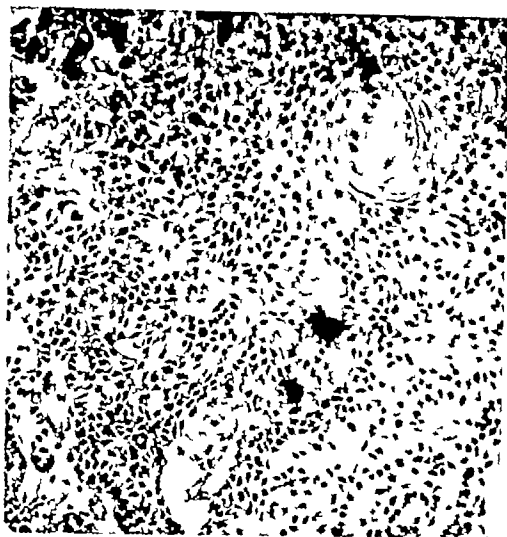


Fig 5 C Case 3 Photomicrograph of tissue (squamous-cell epithelioma Grade II)

3 The small 100-mgm radium pack is an efficient therapeutic medium which can closely rival the large 4- and 5-gram packs

4 Gamma rays produce a more profound effect upon the normal tissues around the tumor than x-rays, rendering them less well able to withstand subsequent interstitial radiation

5 When the filtration of 200 K V x-rays is raised from 0.5 to 2 mm copper, there ensues a less intense epithelitis and epidermitis

6 Maximum tolerances over the same period of time and producing similar reactions occur with from 3 to $3\frac{1}{2}$ skin erythema doses with the radium pack, and from $3\frac{3}{4}$ to 5 skin erythema doses with x-rays filtered through 2 mm copper

7 The above conclusions are offered tentatively, as they are based upon a preliminary report of observations extending over a period of only one year

CASE REPORTS

Cancer of Larynx—Case 1 White male, aged 54, apparently healthy, a slightly hoarse voice, no palpable neck nodes. Indirect laryngoscopic examination is difficult. Direct examination shows a small ulceration on the right vocal cord.

X-ray examination of the larynx shows neoplastic infiltration of the larynx at the level of the cricothyroid cartilage, mainly in the posterior wall of the larynx, resulting in the elevation thereof and of the superimposed soft structure.

The history as taken Nov 14, 1932, is as follows. The onset occurred six months previously with hoarseness which gradually grew worse. Biopsy taken previously showed epidermoid carcinoma. The patient felt better after the biopsy, but soon began to grow worse. There was no dysphagia or pain.

The histologic examination on Oct 17, 1932, showed epidermoid carcinoma, squamous-cell type, Grade I.

There was external radiation with the five-gram radium pack, the technic being as follows: 0.5 Pt plus 5 Pb filter, 6 cm distance, 8 by 10 cm portal, two areas, right and left larynx—one area treated each day for one hour, giving a dose of 5,000 mgm-hrs. From Nov 15, 1932, to Dec 12, 1932 (30 days), treatments were given. The dose to the right larynx was 60,000 mgm-hrs, to the left, 55,000 mgm-hrs, or a total dose of 115,000 mgm-hrs.

The reaction was as follows. On the *fourteenth day*, a slight increase in hoarseness, on the *twenty-first day*, beginning erythema of neck, slight edema of arytenoid, pain, on the *thirtieth day*, beginning denudation of skin, soft tissue edema of neck, marked hoarseness and dysphagia, on the *thirty-sixth day*, islands of beginning healing in the denuded area, voice better, faint dullness of mucosa of larynx, no edema of cords, on the *fifty-sixth day*, skin of the neck healed, dysphagia gone, vocal cords clear, at *four months*, lack of taste, persistent slight submental edema.

On Sept 22, 1933 the lesion was pronounced healed. (See Figs 3-A to 3-F)

Cancer of the Pharynx—Case 2 Physical examination shows a large mass, somewhat movable, in the left neck, measuring 5×7 cm, composed of several nodes adherent to one another. The local lesion is a small, flat, nodular induration, 1.5 cm in diameter, in the lower left tonsillar fossa.

CASE REPORTS AND NEW DEVICES

A CASE OF HEMANGIO- ENDOTHELIOMA¹

By CHARLES H. DEWITT, M.D., Valparaiso
Indiana

The report of William H. Teller, M.D., Leon Solis-Cohen, M.D., and Samuel Levine, M.D., in the March number of *RADIOLOGY*, prompts me to report a somewhat similar case, since the progress of my case may help to answer the problems suggested in the last paragraph of their report.

Miss E. W., aged 55 years, first came under my observation on Nov. 20, 1926. She had a somewhat nodular growth, with several ulcerated areas which bled occasionally, about 6 cm. in diameter and 5 cm. in depth, over the crest of the left tibia in the middle third.

She stated that the growth, which started about twenty years previously, was then a firm, reddish nodule, and not painful. At the onset, it increased in size very slowly, but had been more rapid during the last few months, causing her considerable pain when walking and standing.

Unfortunately, the original roentgenograms are not available, but there was no involvement of bone, although the tumor extended to the periosteum of the tibia.

I made a probable diagnosis of epithelioma, and as the patient refused operation, I gave her x-ray therapy with moderate voltage, and the tumor entirely disappeared. A specimen removed for microscopic study was reported as hemangioendothelioma.

Figure 1 shows the condition two months after treatment. The excavation of the tibia is the result of the removal of thin plates of bone, due to the fact that the bone was exposed for several weeks until it was finally covered by granulation tissue.

One year after treatment, a small reddish nodule, which appeared 2 cm. below the margin of the original growth, responded readily to radiation. At intervals, several similar nodules which appeared outside the area of the original growth, disappeared after radiation.

On Nov. 10, 1933, she reported for another examination, and there was at this time the first evidence of recurrence in the area of the original growth. In addition, she also had one firm enlarged left inguinal node, and complained of pain in the lumbosacral region. However, there was no x-ray evidence of metastasis.



Fig. 1

The patient moved away, and I did not see her after Nov. 10. She died a few months later, and it was reported that she had severe pain in the right shoulder, with considerable coughing which lasted for several weeks prior to her death.

UNUSUAL ACTION ON THE PART OF A FOREIGN BODY¹

By WILLIAM J. CORCORAN, M.D., F.A.C.R.,
Old Forge, Pennsylvania

On April 15, 1926, L. P., a male, aged 41 years, was shot in the back. An x-ray examination made the same day revealed the bullet lying between the bodies of the fourth and fifth lumbar vertebrae (the patient has six lumbar vertebrae (Fig. 1)). Neither the antero-

¹ Accepted for publication July 9, 1934.

¹ Accepted for publication June 25, 1934.

External irradiation was as follows X-ray, 200 K V, 4 ma, 10×15 cm portal, 2 mm Cu and 1 mm Al, 60 cm distance, 200 r = 36 minutes. From Jan 20, 1933, to Feb 10, 1933, 17 treatments were given to each side of the neck, covering two areas a day, at 200 r to each area, making a total of 3,400 r to each area, and a grand total of 6,800 r.

The reaction was as follows. Erythema started in 10 days, at which time the lesion had shrunk to 60 per cent of its original size. On the twenty-second day (last treatment), both necks were fiery red, and there was a superficial scab on the right side. The patient was resting comfortably. The lesion was 25 per cent of its original size, there was no distinct epithelitis, just a faint dullness of the mucosa. On the twenty-sixth day, there was only a slight scab on the ears. The mouth and throat were dry, there was no taste or limitation of motion of tongue.

Histologic examination showed the following: Squamous-cell epithelioma, Grade II.

Interstitial irradiation was as follows

On Feb 21, 1933, occurred the peak of the recession. There was only slight residual induration present. On March 9, 1933, there was a slight recurrence. On March 17, 1933, recurrence reached one-half its original size. Eight gold radon seeds of 0.2 mc each were inserted into the lesion. The dose given was 212 millicurie-hours.

Reaction was as follows. On April 21, 1933, the lesion shrank a little, only to enlarge again. Interstitial radiation was given of 10 gold seeds, dose, 1,356 millicurie-hours. On May 13, 1933, the lesion was healed, after a painful reaction which lasted for three weeks. On July 3, 1933, there appeared a small crater with suspicious edges. Interstitial radiation of 8 gold seeds was applied, dose, 1,600 millicurie-hours.

Progress was as follows. On Aug 1, 1933, the lesion had healed except for a small remaining radium membrane. On Sept 5, 1933, there was secondary breaking down of the area, with the formation of a crater filled with slough, which was painful and debilitating.

posterior nor lateral views disclosed evidence of injury to the bodies. The lateral view (Fig 2) showed the rounded end of the bullet to lie forward and downward. The patient was completely paralyzed in both legs for several days, function gradually being restored to the extent that he was able to walk in two months with the use of canes. In a few more months, he was able to discard these, but always had a wabbling gait and for several years was unable to walk more than three blocks at one time.

Eight years later, he was seized with severe pain, intermittent in character, lasting several weeks. On Feb 3, 1934, he appeared for an x-ray examination. Anteroposterior and lateral views (Figs 3 and 4) showed the bullet within the body of the fourth lumbar vertebrae. A calcified pathway just below the bullet could be seen on the anteroposterior view. The bullet is apparently lodged safely and securely, producing practically no pain. At this writing, June 18, 1934, the patient feels better than at any time during the past eight years.

Many interesting cases have been reported showing unusual action on the part of foreign bodies. It is not often that one sees this in the case of bony structures, even though it be the spongy part that is invaded.

REPORT OF TWO CASES OF DIAPHRAGMATIC HERNIA

By JAMES J. QUINEY, M.D., *Easton,
Pennsylvania*

Case 1. Mrs. J. S., aged 65 years, a widow, was referred for gastro intestinal examination on Dec 8, 1930, with the suggestion that a pyloric obstruction existed.

The patient was well nourished and had a good appetite, but her complexion was sallow, she was extremely nervous, and complained of a persistent unproductive cough which at times interfered with sleep.

She stated that she had lost 10 pounds in the preceding six months, belched quantities of gas, and that her symptoms were aggravated by the intake of any kind of food. She complained of pain, but there was no tenderness at the site of a large abdominal scar resulting from a cholecystectomy and hysterectomy performed 15 years earlier.

A meal administered six hours previous to the fluoroscopic examination was found in the terminal ileum. Following it through by means of the fluoroscope, it was determined that the opaque meal passed through the esophagus and into the stomach in a normal manner. As the stomach filled, it appeared



Fig 1. Note the constricted and puckered appearance of the stomach at the junction of the upper with the mid third.



Fig 2. The leaves of the diaphragm are seen the plane of the left leaf corresponding to the constricted area of the stomach.



Fig 1

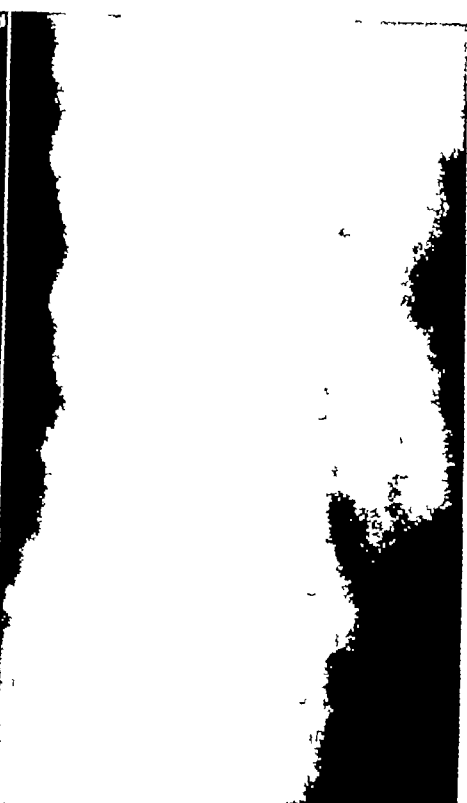


Fig 2

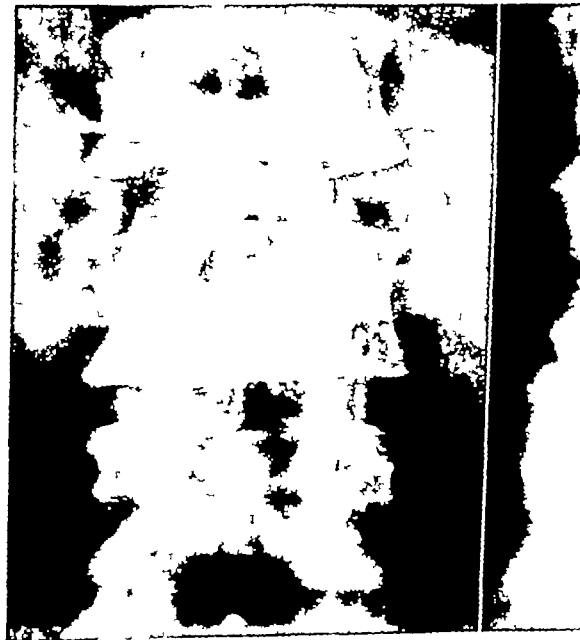


Fig 3



Fig 4

In these cases a diagnosis of pleural effusion is not unusual. One writer reports a case of an infant upon whom paracentesis was done and a flow of milk occurred through the needle, showing that the intestine, which had herniated through the diaphragm, had been perforated.

It would be of interest to know whether, in the case above reported, a hernial opening exists in the diaphragm or the left leaf of the diaphragm is absent.

SYMPTOMLESS CONGENITAL DUPLICATION OF THE LUMBOSACRAL SPINE¹

REPORT OF A CASE

By JOHN S. BOUSLOG, M.D., and ARTHUR ESSERMAN, M.D., *Denver, Colorado*

Although the literature on vertebral anomalies is replete with reports of numerical variations, a careful review of the material has failed to reveal another case similar to the one reported here. It is generally conceded that the lumbosacral region is the most frequent site of vertebral anomalies. Also, spina bifida and supernumerary vertebrae are common, but the latter always occur in the line of the vertebral column (not laterally, as in this case), and the former, properly defined, denotes a failure of the bone to unite over the neural arch. Therefore, the case which motivates this report does not belong in either of those two categories, nor, insofar as we are able to determine, to any other special group.

On Oct. 3, 1932, O. M. C., negro female child, aged nine years, was brought to the Children's Hospital, Denver, by her father because of an acute gastro-intestinal disturbance which proved to be typhoid fever. The patient was the youngest of six children, all the rest of whom (one boy and four girls) and the father were living and well. The mother had had eighteen miscarriages, which had occurred at intervals scattered throughout the six live births. The patient had always been considered frail, and there had been chiropractic treatments.

In the course of the physical examination, the unusual appearance of the patient's back was noted. It looked as if there were a shelf of bone between the ilia and the lower ribs. This seemed to extend bilaterally away from the spinal column. Aside from sluggishness of the left knee jerk, all the reactions were normal.

Roentgen Examination. Roentgenograms of the lumbar and sacral vertebrae revealed anomalous development of the lower lumbar

and sacral segments. The anteroposterior view showed a broad second lumbar vertebra, the lower surface of which was V-shaped, to permit articulation with the bodies of the two third lumbar vertebrae. There were two third, two fourth, and two fifth lumbar vertebrae, and two complete sacra. Only the first segment of the coccyx was present. On the right side, the bodies of the third, fourth, and fifth lumbar vertebrae were fused together, and formed a single osseous mass. Also, the right fifth lumbar vertebra was fused across to the left fifth lumbar vertebra and the left sacrum. Medially, the two sacra articulated with one another. The lateral transverse processes of both sets of the third, fourth, and fifth lumbar vertebrae were present and of average size. The medial transverse processes of the fourth and fifth lumbar vertebrae were vestigial in type, small and somewhat deformed. There was no medial transverse process on the left third lumbar vertebra. Both sacro-iliac regions appeared normal as were all the rest of the vertebrae. The lateral roentgenograms showed no anterior or posterior disalignment. The diagnosis was congenital anomaly (duplication) of the third, fourth, and fifth lumbar vertebrae and the sacrum.

COMMENT

From the foregoing report, it is readily seen that the vertebral anomaly in this patient is a rare, and in all probability, a singular one. It certainly does not belong to the category of spina bifida because the characteristic features are not failure of union of the parts of the vertebrae, but rather a duplication of certain segments.

Among the reports of anomalous vertebral development, the only cases which even partially parallel ours were those in which Brailsford (1) stated that Bowman noted a lack of sacrum and coccyx, and also those in which these portions of the spine were almost a shapeless mass. Brailsford also quoted Decker as describing "a sixth lumbar vertebra, with a spine which split into two unequal portions and an articular surface between." The condition which exists in the third lumbar vertebra of our patient may be similar to the one mentioned by Decker.

Willis (2) said, "the lumbar portion of the column adjacent to the sacrum presents certain morphologic defects, described as bifid and separate arches. The bifid arch is due to arrest of development before fusion of the laminae takes place, the separate arch to irregular ossification with interruption of bony continuity."

¹ Accepted for publication June 20, 1934.



Fig 3 The loculated air-containing areas are separated by thin septa. The heart, trachea, and bronchi are displaced to the right. The left dome of the diaphragm cannot be seen.



Fig 4 The same after ingestion of the barium meal.

shortened in its long diameter. The addition of a barium meal revealed gradual narrowing of the stomach at its upper pole and constriction, with a puckering of the stomach walls, above which it broadened out to normal dimensions. It was also noted that, as the upper segment filled, the food descended through the esophagus in a normal manner to its lower portion and then described a U-turn, the distal portion of the U entering the stomach on a higher level than the base of the U. The domes of the diaphragm were plainly seen below the upper segment of the stomach. The heart was but slightly displaced, if at all.

A diagnosis of hernia of the stomach through the hiatus esophagi was made.

Later, when this patient was again subjected to roentgen examination, a perfectly normal stomach occupying a normal position was found. In arriving at a more complete diagnosis, resort could have been made to the administration of an effervescent drink, which would have resulted in a filling of the segment above the diaphragm with gas, through which the basal lung markings could have been seen.

Case and Upson¹ state that spontaneous reduction of a diaphragmatic hernia prior to examination is not infrequent and that it is thus rendered elusive. These authors report a case demanding immediate operative intervention. They also call attention to the effect of

straining after inspiring. The diaphragm and liver are thus forced downward, giving a better view of the lower end of the esophagus. The Trendelenburg position is advantageous in arriving at a definite conclusion. They also state that the stomach is the first organ to enter the chest through the hernial opening.

Hedblom, quoted by the above authors, reported 343 cases in which the contents of the hernia were stated. In 94, the stomach was the only hollow viscus involved, in 101, the colon and small intestine were implicated, in addition to the stomach, and, in 86, bowel alone was found in the hernia.

Case 2. Z. S., aged 4 years, was referred May 12, 1931, for x-ray examination of the chest. A diagnosis of pleurisy with effusion had been made.

Films and fluoroscopic examination showed a loculated shadow on the left side. The loculi, which contained air, were separated from one another by very thin septa. The heart, trachea, and bronchi were displaced far to the right. The diaphragm on the left side could not be seen. Additional films made following the ingestion of a barium meal revealed the stomach in normal position. The loculated areas were partly filled with barium. It is interesting to note that the intestine extended well up to the apex on the left. The evidence indicated a hernia of the diaphragm, and as no history of traumatism could be elicited, it was considered congenital.

¹ Roentgenologic Aspects of Various Types of Hernia. Jour Am Med Assn. Sept 18 1926.

pressure of diverticula, (8) foreign bodies, with a glove-like distribution, and pigmentation suggestive of a deficiency diet
 (9) localized hypertrophy of the muscle layer
 (B) *Extrinsic Causes*—(1) Pathologic Case 1 C W, male, aged 46 years, an



Fig 1 Showing greatly distended stomach and duodenum

changes in normal attachment, (2) congenital bands, (3) gall bladder inflammation, (4) ptosis of right kidney, (5) gall-bladder adhesions and gallstones, (6) constriction of the duodeno-jejunal opening, (7) anomalies of the pancreas (by hypertrophy, abscess, tumor, bands, and annular pancreas), (8) pressure from aneurysm, enlarged glands, and tumors, (9) prolapse of the colon and small intestine, with or without arterial compression through the superior mesenteric artery or its mid-colic, right colic, or ileo colic branches, (10) compression of the prolapsed jejunum at the pelvic brim

The case herein reported showed a stenosis of the second portion of the duodenum, probably due to progressive duodenitis of six years duration, anemia, a dermatitis of the hands

American machine hand, was referred by Dr E J Duffy because of vomiting during the past six months, which had become so frequent that at the present time he could tolerate only fluids

There was no relation of the vomiting to meals, nor was the pain or previous history suggestive of gastric or duodenal ulcer syndrome. The patient noticed on frequent occasions that he regurgitated food eaten several days before, and that it had a very offensive odor, reminding him of 'sewer gas or carbide'. Six years previously, he began to have attacks of vomiting not related to meals, no accompanying pain, but with much gas and gastric distress. For two years the attacks occurred about once a week, gradually coming on more frequently until, beginning six months ago



Fig 1 Roentgenogram of the lumbar and sacral spine



Fig 2 Sketch of the same

All of the authors studied concur in the statement that the lumbosacral region is the one which is most often the site of anomalous development. Willis (3) also found that although the data were insufficient for conclusive deductions, in 1,471 skeletons, as regards vertebral variability, there is a slight excess of the females over the males and of the negro over the white. He also found that there is a more marked tendency to lengthening than to shortening of the column.

Etiologically, the condition we report may be similar to those anomalies which result in separate neural arches, and it may belong to either the monster group or it may be of embryonic origin.

SUMMARY

A case of duplication of the third, fourth, and fifth lumbar vertebrae and all of the sacral segments of the spine, and broadening of the second lumbar vertebra, is reported. The patient is a negro girl. This seems to be the only case of its kind on record.

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CHRONIC DUODENAL STENOSIS IN THE ADULT

REPORT OF A CASE WITH A RESULTING SECONDARY DEFICIENCY SYNDROME

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Chronic duodenal stenosis is caused by a number of distinct pathologic processes which may involve the first, second, or third portion of the duodenum. For convenience, it may be divided into the following classification:

- (A) *Intrinsic Causes*—(1) Abnormalities of shape or position, (2) acute and chronic duodenitis, (3) hypertrophy of the valvulae conniventes, (4) congenital narrowing, (5) benign and malignant tumors, (6) ulcer, (7)

pressure of diverticula, (8) foreign bodies, with a glove-like distribution, and pigmentation suggestive of a deficiency diet
 (9) localized hypertrophy of the muscle layer
 (B) *Extrinsic Causes*—(1) Pathologic Case 1 C W, male, aged 46 years, an



Fig 1 Showing greatly distended stomach and duodenum

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The case herein reported showed a stenosis of the second portion of the duodenum, probably due to progressive duodenitis of six years' duration, anemia, a dermatitis of the hands

American machine hand, was referred by Dr E J Duffy because of vomiting during the past six months, which had become so frequent that at the present time he could tolerate only fluids

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On June 8, 1931, under spinal novocaine anesthesia, the abdomen was opened by Dr A W Carley who found the stomach to be greatly distended. The gastro-colic ligament was divided to expose the third portion of the duodenum. Beginning about the second portion, the duodenum, which began to narrow to a point three-fourths inch below the diameter (Fig 2), by vision and palpation, seemed to be about from 3 to 4 mm in diameter, gradually enlarging in a conical manner for another three-quarters of an inch, when it again assumed its normal size. The appearance of the stenosis resembled a section of a glass tube drawn out to the 3 mm diameter over a Bunsen burner. There was no internal or external cause apparent. The stenotic area was smooth, and a few fine lace-like adhesions were present over the narrowest portion. A posterior gastro-enterostomy was done and the abdomen closed. Five hundred cc of 5 per cent glucose in normal saline solution was given intravenously. The convalescence was uneventful and the patient returned to work eight weeks later. He had gained 30 pounds in weight, the eruption had cleaned up, and he could eat without distress.

COMMENT

The principal interest attached to this case lies in the combination of a gradually developing stenosis of the duodenum with evidence of a concomitant deficiency disease believed due to an inadequate diet engendered by the progressive stenosis. The lesions on the hands resembled pellagra, with the characteristic glove-like distribution of the dermatitis, the pigmentation, the vesicles, the bullæ and the old scars, and general symptoms of atrophic glossitis and red tongue. Pellagra is thought to be due to a lack of Vitamin B, and in this instance the lack of fruits, vegetables, and other vitamin-bearing foods over a period of several years may have been the predisposing factor in its production. Snell and Bumpus (2) report a somewhat similar circumstance. Their case presented a deficiency syndrome with duodenal obstruction and ulcerative colitis, with an attempt at correction of the obstruction by a gastro-enterostomy. Death was sudden and apparently similar to deaths occurring in deficiency disorders. Kellogg's (1) recent excellent volume contains no reference to a similar condition.

CONCLUSION

1. Herein is reported a case of chronic duodenal stenosis in an adult, probably due to intrinsic inflammation of unknown etiology, and also its part in producing a pellagra-like

lesion as the result of a subsequent inadequate diet.

2. Cure of both lesions was affected by a gastro-enterostomy.

REFERENCES

- (1) KELLOGG E L. The Duodenum. Paul B Hoeber, 1933. page 367.
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CHOLECYSTO-DUODENAL FISTULA WITH GALLSTONE OBSTRUCTION OF THE SMALL INTESTINE. A REPORT OF TWO CASES¹

By L W PAUL, M D, Madison Wisconsin

Assistant Professor of Radiology, University of Wisconsin Medical School

Occasional reports of cases of spontaneous fistula formation between the gall bladder and duodenum are to be found in the literature but the total number of such reported cases is still relatively small. The most recent one is that by Sickels and Hudson² in which they tabulate the cases reported, a total of 29, and add one of their own. In addition to these there were ten cases reported in which the filling of the bile ducts during a barium meal examination was stated to be due to reflux through the ampulla of Vater, but only five of these had surgical or postmortem verification.

Due to the apparent rarity of the condition and the unusual features in one of them, the following two cases are presented.

Case 1. The patient, a white female, 60 years of age, was admitted to the State of Wisconsin General Hospital on July 31, 1933, in a stuporous state, having been ill at home for the previous ten days. It was impossible to obtain an adequate history from the patient but the referring physician supplied enough information to justify the impression of bowel obstruction. There was nausea, vomiting, and abdominal distention. Under conservative treatment the patient improved, the distention subsided, and normal bowel movements occurred. However, the temperature continued to rise to 100° every afternoon. A roentgen examination by means of a barium meal was done on Aug 8, 1933, it was reported

¹ From the Department of Radiology and Physical Therapy, University of Wisconsin. Chairman Ernst A Pohle M D Ph D, Professor of Radiology.

² SICKELS T N and HUDSON, C L. Demonstration of a Spontaneous Biliary Fistula by Roentgen Examination. Am Jour Roentgenol and Rad Ther January 1934 31, 31-36.

they occurred as often as several times daily. During this time the diet was inadequate, he ate few fruits and vegetables, subsisting al-

tissue turgor was poor and both ankles were swollen, both superficial and deep reflexes were normal, no superficial lymph glands were

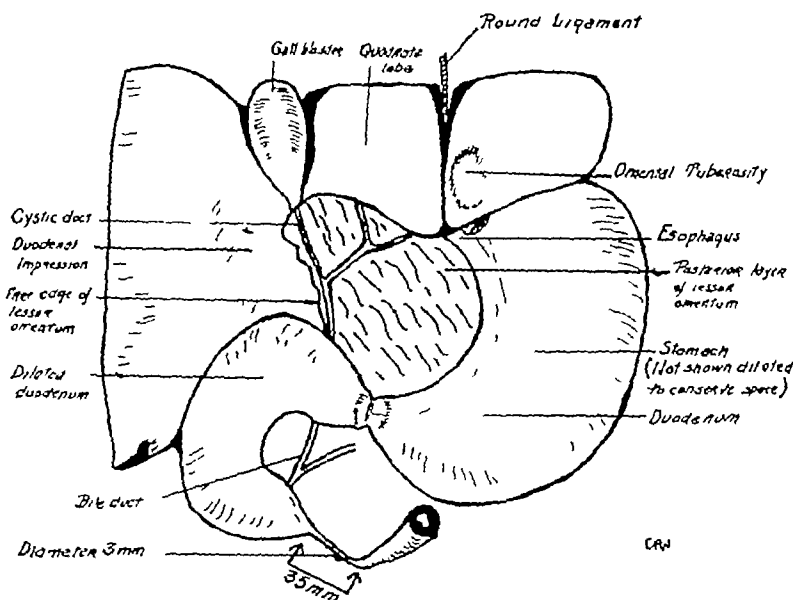


Fig 2 Diagrammatic sketch, showing site of the duodenal stenosis

most entirely on fluids. As a result, there was progressive loss of weight and an eruption appeared on both hands up to the wrist line. A factory physician, whom he had consulted, told him that he had anemia, a few days later the patient collapsed while at work.

At this time he was referred by Dr E J Duffy for a diagnostic survey, the results of which portrayed the following. The patient was a pale, thin, anemic looking man, with haggard face, pigmented exposed areas, particularly the hands, where the lesions were bilateral and glove-like in distribution, with evident vesicles, bullæ, and old scars. The head was symmetrical, the pupils reacted to light and distance, the ears were normal, the turbinates were enlarged on the left side and the septum deviated to this side, tonsillar tags were present, the tongue was clean, smooth, and bright red, with areas of atrophic glossitis. The teeth were dirty, a mild grade of pyorrhea being present, and most of the molars were missing, the mucous membranes were pale. The thyroid was normal in size. The pulse rate was 72, the blood pressure, systolic 96, diastolic 66, pulse pressure 30, the heart normal in size by measurement and no bruits heard, the lungs normal, the abdomen greatly enlarged, about the appearance of a uterus at term, tympany was noted throughout. The

present, internal and external hemorrhoids were present, the prostate was normal.

A gastro-intestinal study revealed a normal esophagus and a stomach so greatly dilated as to fill the entire abdomen. The first part of the liquid barium entered the duodenum freely and then began to "back up." The first portion of the duodenum was dilated to thrice its normal size and reverse peristalsis was noted. By pressing the greater curvature of the stomach upward, and the first portion of the duodenum to the left, the second part of the duodenum was seen to narrow down to a diameter of what appeared to be from 2 to 3 mm, the barium slowly trickling through this into a normal third portion where it passed along at its usual rate. No masses or nodules were noted along this part. A very large residuum was present after six hours (Fig 1). The colon by enema was normal. The laboratory work showed a normal urine. The hemoglobin was 66 per cent (Dare), red blood cells, 3,220,000 white blood cells, 8,200, polymorphonuclear leukocytes, 67 per cent, small lymphocytes 31 per cent, and large lymphocytes, 2 per cent. The blood Wassermann and Kahn tests were negative, blood chlorides were 450 mg per 100 c.c. of blood.

A diagnosis of duodenal obstruction, etiology unknown, was made and operation advised.

On June 8, 1931, under spinal novocaine anesthesia, the abdomen was opened by Dr A W Carley who found the stomach to be greatly distended. The gastro-colic ligament was divided to expose the third portion of the duodenum. Beginning about the second portion, the duodenum, which began to narrow to a point three-fourths inch below the diameter (Fig 2), by vision and palpation, seemed to be about from 3 to 4 mm in diameter, gradually enlarging in a conical manner for another three-quarters of an inch, when it again assumed its normal size. The appearance of the stenosis resembled a section of a glass tube drawn out to the 3 mm diameter over a Bunsen burner. There was no internal or external cause apparent. The stenotic area was smooth, and a few fine lace-like adhesions were present over the narrowest portion. A posterior gastro-enterostomy was done and the abdomen closed. Five hundred c c of 5 per cent glucose in normal saline solution was given intravenously. The convalescence was uneventful and the patient returned to work eight weeks later. He had gained 30 pounds in weight, the eruption had cleaned up, and he could eat without distress.

COMMENT

The principal interest attached to this case lies in the combination of a gradually developing stenosis of the duodenum with evidence of a concomitant deficiency disease believed due to an inadequate diet engendered by the progressive stenosis. The lesions on the hands resembled pellagra, with the characteristic glove-like distribution of the dermatitis, the pigmentation, the vesicles, the bullae and the old scars, and general symptoms of atrophic glossitis and red tongue. Pellagra is thought to be due to a lack of Vitamin B, and in this instance the lack of fruits, vegetables, and other vitamin-bearing foods over a period of several years may have been the predisposing factor in its production. Snell and Bumpus (2) report a somewhat similar circumstance. Their case presented a deficiency syndrome with duodenal obstruction and ulcerative colitis, with an attempt at correction of the obstruction by a gastro-enterostomy. Death was sudden and apparently similar to deaths occurring in deficiency disorders. Kellogg's (1) recent excellent volume contains no reference to a similar condition.

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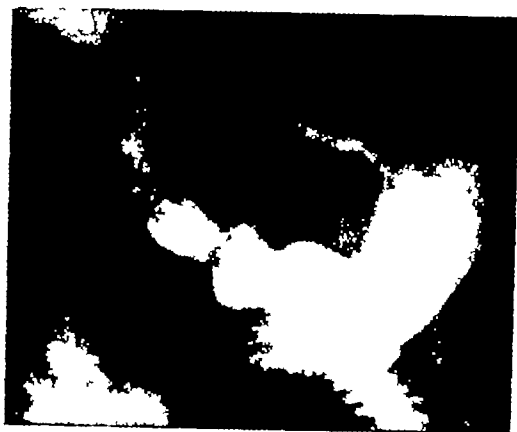


Fig 1 Case 1 The common and hepatic ducts are filled with barium. Film taken shortly after the meal was given

as follows. The patient was examined fluoroscopically in the recumbent position only. The heart appeared widened and the entire aortic arch was prominent. There was no delay in the passage of the meal through the esophagus nor at the cardia. The stomach filled out in a normal manner and showed normal peristalsis. The bulb filled spontaneously, was deformed, and there was an irregular tract filled with barium extending upward from the apex of the cap for a distance of several centimeters. The roentgenograms showed a stomach normal in size and with regular and even peristalsis. The bulb was grossly deformed and barium had escaped through a fistula into the common duct which was outlined almost throughout its entire extent. Both the right and left hepatic ducts were visualized as was the cystic duct, but none of the barium had entered the gall bladder. At six hours a small residue remained in the stomach. Many of the smaller bile ducts were filled with barium, as was the distal portion of the common duct. The head of the meal was in the lower ileum, with barium scattered throughout the small bowel, some loops of which were dilated. At 24 hours, several of the small bile ducts still contained barium. The balance of the meal was scattered throughout the colon which was in a contracted state.

Impression—This examination demonstrates a fistulous connection between the duodenal bulb and the bile passages, probably the common duct. While it is possible for the fistula to be between the cap and gall bladder, the absence of gall-bladder filling makes this seem unlikely.

Upon further questioning, the patient stated that, while at the height of her illness, she had digitally removed a large stone from the rectum



Fig 2 Case 2 Arrow points to common and hepatic ducts filled with air. Air is visible in the gall bladder. Dilated gas-filled coils may be seen in the left upper quadrant.

before her admittance to the hospital. Operation was performed on Aug 18, 1933, by Dr J W Gale. The duodenum and pylorus were densely adherent in the region where the gall bladder should have been. After a long search the gall bladder was found. It was only one inch in length and no thicker than a lead pencil. A line of cleavage was found which opened into the duodenum just distal to the pylorus. The defect was between what remained of the gall bladder and the duodenum. The failure to fill the gall bladder clearly in this case was probably due to its small size and contracted state. The opening was closed and the gall bladder removed. Her convalescence was uneventful.

Case 2 The patient, a white male, 64 years of age, was admitted to the State of Wisconsin General Hospital on Feb 1, 1934. He had had an appendectomy for acute appendicitis eight months previously, at which time several large stones were palpated in the gall bladder. Because of the toxic condition of the patient, cholecystectomy was not done. The present illness began several days before admission with cramp like pains in the abdomen, and emesis. No bowel movements had occurred after the first day. The abdomen was distended and there was over-active peristalsis

in the left lower quadrant. A flat film of the abdomen taken in the upright position was reported as follows: There was a group of dilated coils of gas-filled small intestine in the left upper quadrant, with scattered areas of gas throughout the remainder of the abdomen. There was a Y-shaped collection of air extending upward and obliquely from the level of the second lumbar vertebra, with a rounded gas bubble adjacent. This was believed to represent air in the common and hepatic ducts and possibly in the gall bladder as well. These findings would indicate the presence of a cholecystoduodenal fistula, most likely the result of ulceration from a gallstone which had caused an obstruction in the jejunum.

Laparotomy was performed on Feb. 3, 1934, by Dr. J. W. Gale. There was found a U loop in the ileum, due to adhesions. Proximal to this was a large gallstone the size of a hulled walnut. This was removed through an incision in the small bowel, it being impossible to force the stone into the cecum even after the adhesions were broken up. The patient's condition did not warrant further exploration or operative procedure. The post-operative course was satisfactory. Before discharge, a barium meal examination was done but none of the contrast substance could be seen entering the gall bladder.

This case illustrates the possibility of demonstrating fistulous connections between the gall bladder and duodenum by means of a flat-film examination and without the use of an opaque meal. It also confirms the value of flat-film examination in cases of acute bowel obstruction since in this instance an accurate diagnosis of the location and cause of the obstruction could be made before operation. Similar findings have been reported in only a few instances, and in one of the cases reported by Sickels and Hudson, air in the hepatic ducts was seen following a surgical anastomosis of the gall bladder and the duodenum.

In both of the cases reported in this paper there had been an ulceration of a large gallstone into the duodenum, with resulting small intestinal obstruction. In Case 1 the patient eventually passed the stone by rectum but the fistula persisted. In Case 2 the stone was stopped by a constriction in the bowel due to adhesions, necessitating operation for relief. Attempts at demonstration of the fistula after operation were unsuccessful and the patient was clinically well, indicating that healing may have occurred after the obstruction was relieved.

A SLIDE-RULE FOR CALCULATING RADIATION EXPOSURE WHEN CELLS OF UNIFORM RADIUM CONTENT ARE USED¹

By IRVING FRIEDMAN, M.D. *New Haven, Connecticut*

Following the suggestion of Dr. George T. Pack, the New Haven Hospital has recently adopted the method of keeping radium in small, uniform, platinum cells, each containing three and a third milligrams of element. In this form the radium may be used in a large variety of applicators, also, the calculation of dosage is thereby greatly facilitated.

A slide-rule has been devised which still further simplifies the calculation of exposure. Figures 1 and 2 illustrate the two faces of this instrument. On one side (Fig. 1) is a scale of logarithmic form, to compute the duration of exposure required in order to administer a desired amount of radiation with a given number of cells. On the other side (Fig. 2) is a scale of linear form, to determine the time of the day when the exposure should be terminated.

The operation of this device is best explained by the following illustrative example. Suppose that a dose of 3,600 milligram-hours of radiation is to be given in an applicator containing 16 cells, and that treatment is begun at 11 A.M.

The first sliding scale is adjusted so that the indicator points to 3,600 milligram-hours of radiation (Fig. 1). The required exposure is then read on the lowermost scale opposite 16, the number of cells, which would be in this case 67.5 hours.

The rule is then turned over, and the second sliding scale adjusted so that one of the two indicators points to 11 A.M. If the left-hand indicator were used (not illustrated), 67.5 hours would fall beyond the calibrated scale. In this instance, therefore, the right-hand indicator must be used, and it is then seen (Fig. 2) that the treatment should be terminated at 6:30 A.M. of the third day, the day being read on the same side as the indicator which marks the beginning of the exposure.

The slide-rule may be used with equal facility to calculate the amount of a given dose of radiation. Thus if the applicator in the above example were to be removed at 9 A.M. of the next day, this would complete 22 hours of exposure (Fig. 2). The first scale could then be set with 16 cells opposite the 22 hours (not illustrated), and the dosage read opposite the indicator, which would be in this case about 1,170 milligram-hours.

¹ Accepted for publication July 9, 1934.

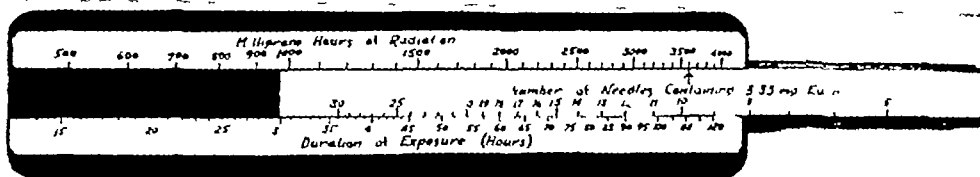


Fig 1 (Upper)

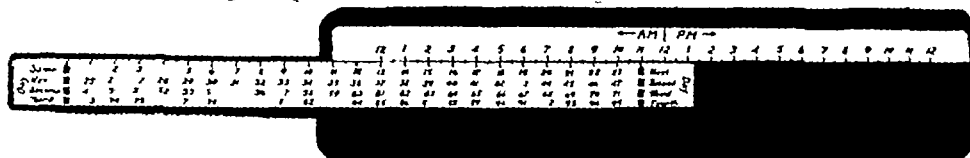


Fig 2 (Lower)

A properly made slide-rule of this type should be accurate to within a small fraction of 1 per cent. If uniform cells are used which have a radium content of other than 3.33 milligrams,

it is necessary to change the calibration of the first sliding scale in order to make the instrument applicable.

New Haven Hospital

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE ALL-ROUND-SQUARE MAN

Mark Twain's words come to me as an appropriate caption for what I have in mind.

Just what is our conception of a valuable life? Let us endeavor to draw some picture of what this title suggests. We see possibly the vision of a man great for his physical robustness, known for his breadth of vision, and respected for his uprightness of living. Somewhere between the pictures of the long-nosed pessimist and that of the overwhelming optimist, hangs the cameo we are seeking. The popular feminine conception lies perhaps out in Hollywood, and alas, the masculine idea, to judge from the papers, is secretly built up from the haunts of our underworld in the backstreets of Chicago, or in Edgar Wallace's productions.

But I do not propose to analyze the Clark Gables, however fetching their dimples, nor our Dillingers (a soft or a hard G, whichever you prefer). My attention wishes to draw yours in conceiving something of the essence essential to the fullness of life for the average professional man.

We, as professional men, are so habituated to speaking *ex cathedra* that we might well stop and ask ourselves just how far we are carrying this principle into every other department of our thought and action. Possibly we take for granted that we are well-rounded individuals. I find it a temptation to speak quite authoritatively on almost anything, since the public expects it, and it is hard to resist perpetuating such a myth. Of course it has long been an axiom among the racketeers that we professional men and women are the leading suckers and prize boobs for every imaginable speculation. Apparently it is our weakness, that, being trained in one field, we take for granted our knowledge in every other, and are quite unaware, and blissfully ignorant, that a scientific bent does not necessarily presage commercial talent, to their exceeding profit and our own certain distress and sorrow in the end.

But let us carry this further afield. Exactly what height and depth of view do we possess

outside of our own specialist's training? I am asking myself—am I allowing the absorbing professional existence of to-day to so narrow me down that I am out of touch and, therefore, largely out of sympathy with the major problems of "Everyman"? Where are the cultural and esthetic values which theoretically we acknowledge, but which have so little place in our own practical world?

Of course, you answer that we all join clubs to help meet this. But even with this advantage, it becomes very doubtful, since we are apt to merge our views with those of the group, and so confirm the obscurantism of our outlook.

Is it not rather pathetic to meet men distinguished in their particular fields, who yet might be living in Mars for all the contact they have with the life around them? One is tempted to suggest that their work suffers accordingly.

We all need an escape—some way to relieve the strain of the day and to give us time to regain some sense of the real values of life. After all, a man's work is done in a very narrow environment. His office and task chain him down, and it is with relief that he turns home at five o'clock (if he be fortunate), and allows his attention to rest by giving it a change. No doubt the modern detective story is the result of the times and the strenuous rushing life of the average man, who lives so strained an existence that he needs something more than even so pleasant a thing as chatting with his wife or cutting the lawn, to break the strain of the day. Some, of course, find relief in golf and bridge, others in politics and such-like sport, others have built up an "Ivory Tower" to which they may retreat from all the "slings and arrows of outrageous fortune." Whatever it is, it is essential to our well-being, and there is certain tragedy being stored up for the man who cannot "let go."

There is also, quite apart from the question of the modern pace which is undoubtedly shortening the lives of so many of us, a time in the life of "Everyman" when Nature says

"Slow up" The handwriting is on the wall, and woe betide that man who thinks he can ignore it. Is it not a false sense of pride which makes us afraid to face facts? Is our life so ill-arranged and ill-prepared that we fear to consider such a possibility and cannot face such a reality without a tremor? The Greeks of old knew better. There is surely a wrong perspective on life when we cannot meet the next inevitable step. Apparently the majority of us are so fixated by habit that we cannot be moved except by a miracle, and that usually comes too late and so finishes us. Surely the mature man can find a deeper satisfaction and a more useful sphere for himself by just stepping aside—be it ever so little—and leading a less engrossed life, less caught by the turmoil of ceaseless activity.

Watch the minds of those leading our armies in battle! Do they rush forward with sword in hand? That day is over for them. We find them standing back, and with their experience they are able to direct and suggest the most likely course of action. Their contribution is invaluable and necessary. All their training leads up to it, and in such values is success found. But in the ordinary life of the citizen we utterly ignore this fact. We senselessly imagine that because a man has left the front-line trench he is no longer of the faintest use—perhaps, because he leaves it too late. Actually he should be of greater use than ever before since he now has time for reflection. Our insane glorification of the active life has made us sacrifice some of the best values life has to offer, and made men afraid to face what is so inevitable. The disastrous results of attempting to hold on are pathetic to see. Man's 'will-to-power' ends by making him a slave, riding him, tyrannizing over him and all who come within its reach. The indispensable elements of life for the individual are surely deeper than this. The crystallization of a man's contribution probably never ripens till after he has ceased the violent urges of his existence, and had time to reflect and weigh. We may well pity the man who never reaches that stage. He is like fruit that never fully matures.

However, it is only in passing that I stop to consider this angle of the 'all-round-square' man. I want particularly to approach him in the light of the average professional. Just what does he see in life outside of his work? Do we not live for the most part sublimely

unconscious of the great world about us? In one sense this is our forte and safeguard, on the other hand it is our weakness, affecting our work and leading many of us to question the richness of our existence. It is not that we want to make of our days a sixteen or thirty-two page "yellow" journal. Heaven forbid! But there is an unnecessary meagerness about our lives, stifling and dulling in its effects. No doubt you feel as I do, that, having one life to live, it should be lived fully, richly, and completely, not in abnegation but in constructive realization should we fulfill ourselves. We all seek a richly rounded existence which, rising to a final curtain, shall have fully completed itself. But deeply satisfying as our work may be, there come to many of us moments of doubt and a sense of futility, which, it seems to me, are largely in our own hands to remedy.

I think of man in terms of his reserve forces, just what he builds up to keep his outlook well balanced, so that it may properly mature, what he has as reserves for the day when just mere activity passes from him. The best authorities are unanimous in agreeing that the man cannot give of his best who limits himself just to his work. Broader horizons are necessary if he would see straight. The complaint of poverty of life can be overcome in the riches of values other than our own. We hear a great deal about 'national preparedness' these days, but what of individual preparedness? We need to build up reserves of the spirit, the content of which is the essence of our real and ultimate value to the world, and which must be guarded with a two edged sword. If we disregard this and dissipate life in just quantitative things, we shall find the accumulation of our days dispirited indeed.

Can we escape the insidious fixation of the routine of clinical life which threatens to so circumscribe our outlook that we fail or lack time to see the finer and deeper gifts awaiting us? I think we can. But it is only by guarding the treasure of life, constantly keeping open the broader and deeper avenues of thought, that we can enter into the life of the community with a better estimate of the necessities of other men's lives.

Then in the glow of the setting sun we shall find life triumphant, no longer shall we be desperately clinging in frantic competition to keep up with the coming tide of youth, but able to offer a quiet and sincere contribution from a mind at peace with itself, well balanced,

and having a breadth of vision denied to those just leaping into the game. In a word, an "all-round-square" man

W HERBERT MCGUFFIN, M D

COMMUNICATIONS

THE FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY

ZURICH—ST MORITZ, SWITZERLAND,
JULY 24-31, 1934

The Fourth International Congress when viewed in the light of present-day economic stress and international unrest must be rightfully permitted to take place and rank with the three previous admittedly successful congresses. Great credit for this happy conclusion is willingly granted the able and energetic President, Dr Hans R Schinz, and his equally efficient and courteous Secretary-General, Dr Hans E Walther. It is impractical to name all of the officers and local committeemen who served faithfully and well but outstanding among them are Vice-president, Dr René Gilbert, and Assistant Secretary Dr Stewart-Harrison.

Scientific Program—This on the whole was excellent and not overbalanced by social functions as has occurred on former occasions. Some criticism, however, has been directed against the over-abundance of material, which resulted in limiting the essayists, with a few exceptions, to ten minutes each. Over two hundred articles were read, they will be published in book form and sent to all members later.

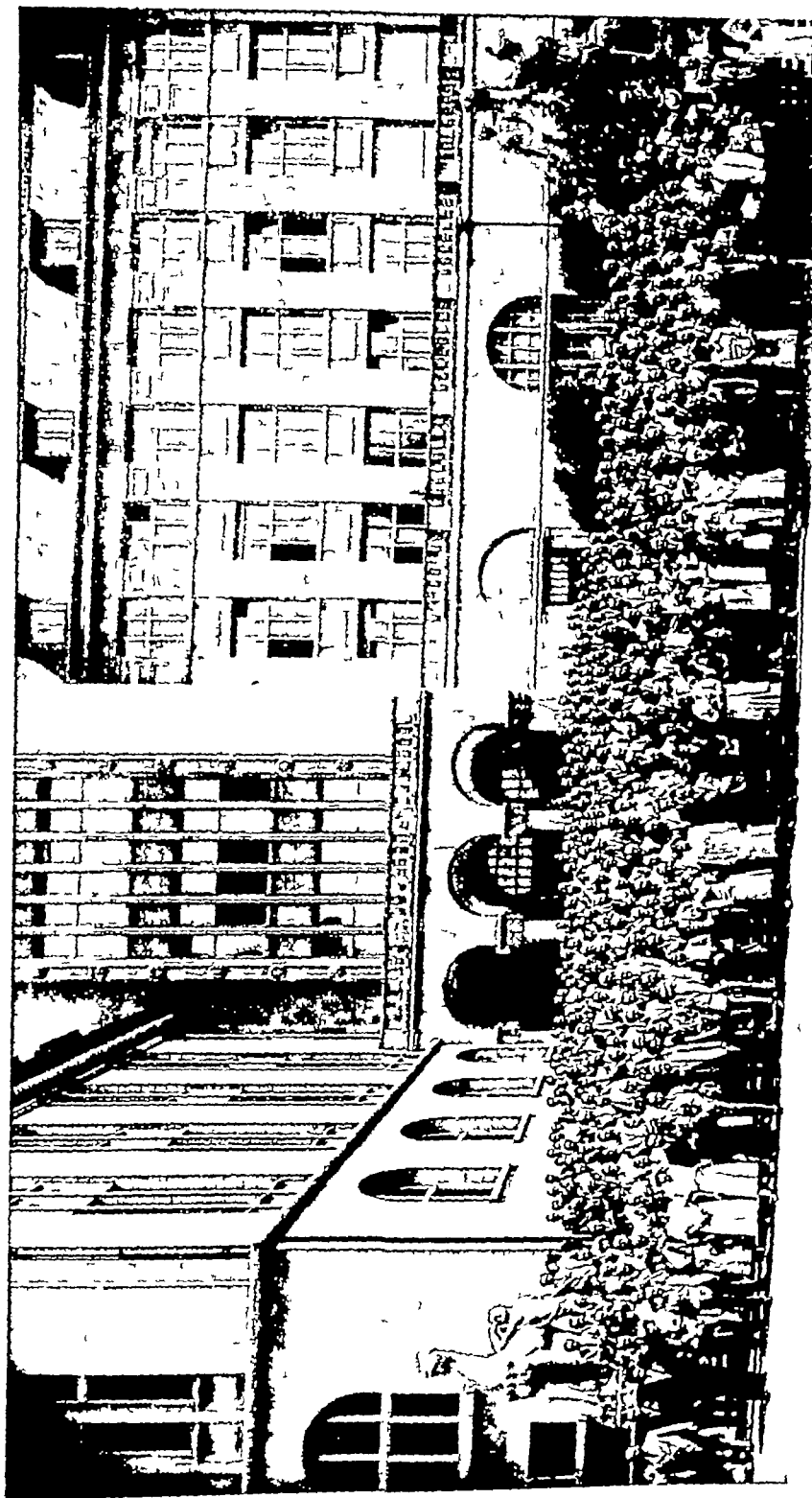
Scientific Exhibits—These were representative and quite up to our own American standards. One unusual feature was a demonstration of the use of diagnostic roentgenology in the detection of flaws in a great many opaque materials. Also the detection of altered penmanship in forged papers or documents and in fraudulent paintings, etc.

Commercial Exhibits—Here was a revelation—or, one might say, a revolution—in the character of apparatus since the first Congress in London just nine years ago. The sturdy construction, the excellent workmanship and pleasing appearance of nearly all x-ray apparatus and accessories assembled were arresting. The radiologist looks upon this scene with both admiration and alarm, for is it

not necessary for him now to discard certain equipment purchased two or three years ago? And how is he to set aside from his meager income sufficient funds to obtain this ultra-modern apparatus so necessary if he is to maintain equality with his more fortunate brother radiologists in this sharply competitive electrical era? Would that the non-radiological practitioner of medicine and surgery, and the average patient could be made to appreciate this situation!

The Opening Session—The ceremonial opening session with over 1,200 delegates from 43 countries present will be long remembered. The Stadtteater at Zurich was beautifully decorated with flowers and festoons and the seats were all occupied—perhaps 2,000 in all and 13 speakers on the stage. President Schinz of the Congress opened the meeting, with a response from Dr Bécclère. Bundesrat Dr Etter addressed the meeting on behalf of the government. Responses were made by Dr C Thurstan Holland, Prof Maier, and Prof Niggli. Prof Forssell, representing Sweden, then opened the International Cancer Conference, to which 27 nations had contributed. The following were invited to respond in order named: Dr Soiland, for U S A, Dr Ledoux-Lebard, for France, Prof Palmieri, for Italy, Prof Maisin, for Belgium. This was followed by Prof Sauerbruch, of Germany, who spoke on the surgical side of cancer treatment, to which Prof Frick, of Germany, responded on the radiological side of the question. The session closed with an orchestral rendition of the national hymn. That evening an unusual Swiss festival was staged for the benefit of the members at the Dolder Grand Hotel and environs. It is called *Mistura Helvetia* and consists of groups of men and women from the different Swiss districts, in their colorful costumes of every design, singing, dancing, and yodeling to the harvest moon. There were some fine songs, good symbolic dancing, and some ritualistic performances with grotesque and hideous masks. Huge bonfires on the slopes below the hotel terminated the fête.

Business Session—Before the International Executive Committee, the official delegates from the United States invited the next congress to America in 1937. Italy and Germany also presented invitations. After some discussion the latter countries graciously withdrew and the United States received the unanimous



Fourth International Congress of Radiology, Zurich-St. Moritz July 24-31, 1934

vote of the delegates assembled. The basic law of the International Congress of Radiology provides that the country selected for the meeting shall, through its official delegation, elect the president of the congress and name the time and place of the meeting. Our delegation consisted of Dr B H Orndoff, Radiological Society of North America, President, Dr Lawrence Reynolds, American Roentgen Ray Society, Vice-president, Dr Albert Soiland, American Medical Association, Section on Radiology, Secretary, Dr G Failla, American Radium Society, Dr Byron H Jackson, American College of Radiology, absent. Dr W W Wasson, alternate to Dr Jackson, was also absent. The four delegates present discussed earnestly the problems connected with their new responsibilities. It was finally unanimously decided that Dr Arthur C Christie, of Washington, D C, was well qualified to carry the honor and responsibility of conducting the Fifth International Congress of Radiology to a successful conclusion. The question of a meeting place was most seriously discussed, with New York, Washington, and Chicago strong favorites. After considerable debate it developed that Chicago had facilities for housing the whole Congress under one roof including members, exhibits, committee rooms, meeting rooms, etc. Dr Benjamin H Orndoff was elected Secretary-General by unanimous action and as President of our delegation presented our decision to the body assembled. Our delegation had suggested June as a tentative time but it developed that the great majority present preferred September. President Schinz then announced the result. Fifth Congress, U S A, Dr A C Christie, President, Dr B H Orndoff, Secretary-General, place, Chicago, Illinois, time, early in September, 1937. Action warmly applauded by all delegates seated.

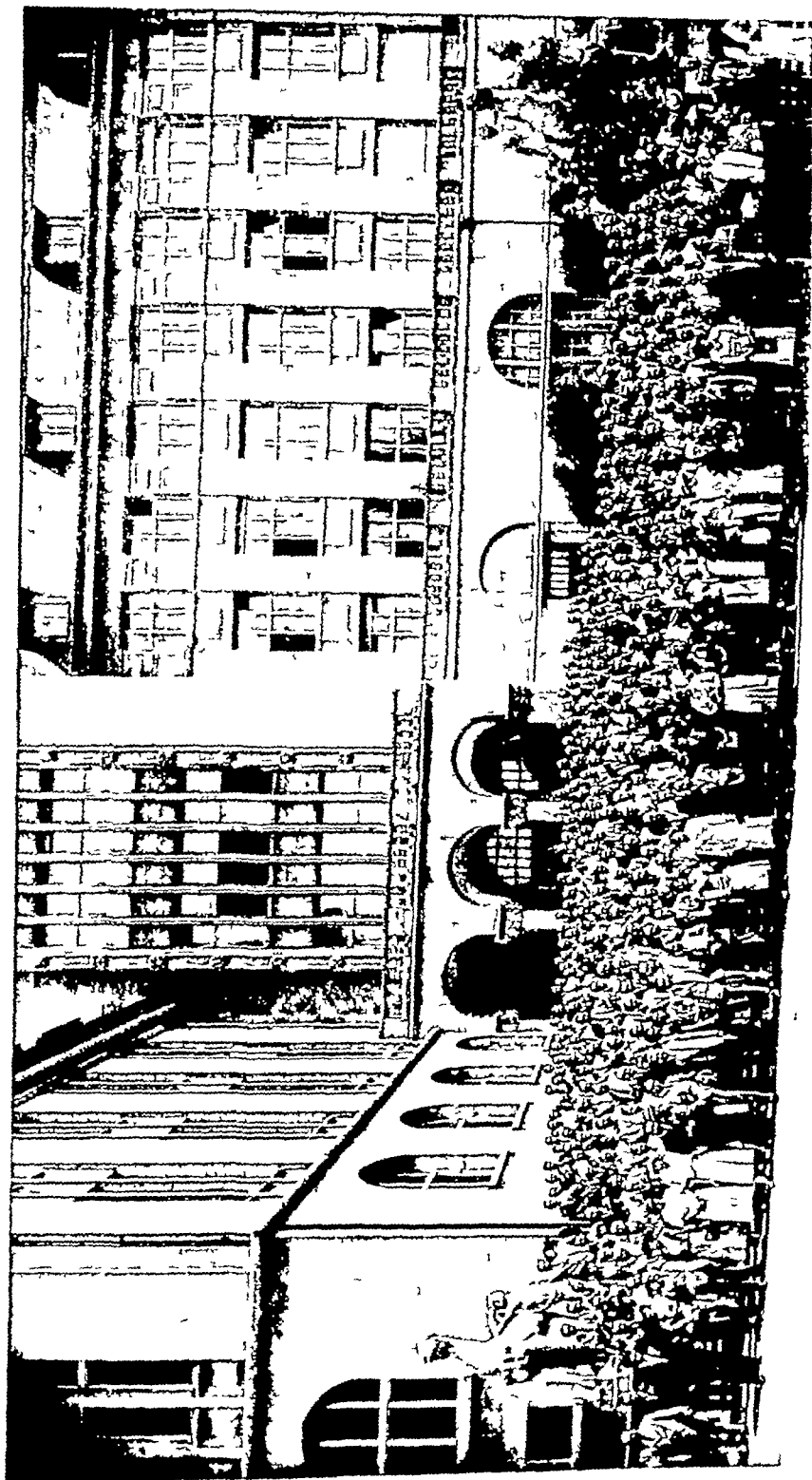
Sessions—The scientific sessions occupied four days of the total seven in Zurich and were operated in four sections, the meeting places being the University Building and the Technical High School. The arrangements for lanterns, illumination, and general facilities were adequate.

St Moritz—Special trains were provided on the narrow gauge railroad for St Moritz, and the climb up to the tiny azure blue lake completely surrounded by ice-capped mountain peaks is beyond description. Our hotel, the Palace, was situated on the border of this

placid lake which was fringed by beautiful green foliage, shrubbery, and stately pines, the latter ascending the mountain slopes. Sunday was a day of rest and relaxation except for those members who ventured up into the snowy heights.

The American College of Radiology—The Fourth International Conference was held at the Hotel Kulm, where Executive Secretary Orndoff had arranged for our sessions. A brief reception was held before the dinner to which English-speaking Congress members had been invited. This proved a pleasing innovation. After dinner Secretary Orndoff introduced the Presiding Officer, who, in the name of President Groover (unfortunately prevented from attending the Congress), conferred the degree of Honorary Fellowship upon Prof Aristide Busi, the Dean of Italy's radiologists. Fellow Busi responded in the Italian language which was ably translated into English by Fellow Tandoja. The topic of the Conference was then called for, namely, recent trends and present status of the practice of medical radiology. Honorary Fellow C Thurstan Holland responded for the British Isles, Honorary Fellow Gosta Forssell for Scandinavia and Northern Europe, Honorary Fellow Hans Schinz for Switzerland and Central Europe, Honorary Fellow Pasquale Tandoja for Italy and Southern Europe, and Fellow George E Pfahler for the United States. Dr Pfahler spoke feelingly upon the splendid spirit of comradeship which had accrued to the Fellows of the College through these international conferences. He prophesied a truly harmonious and profitable future for our College. Honorary Fellow Antoine Béclère responded in like vein, and at the conclusion of the session your scribe heard a great many complimentary remarks, directed principally toward our efficient and tireless Executive Secretary for his altruistic work for the College. The roll call demonstrated the presence of 17 Honorary Fellows, 19 regular Fellows, and 14 guests, a total of 50.

The Congress—The following day scientific sessions were resumed, which came to a close Tuesday evening with, first, a closing ceremonial at the Stadium and, later, a subscription banquet (20 Swiss francs per plate). One noted quite acutely the thin American dollar which melted so rapidly in Switzerland. Wednesday and Thursday were devoted to sight-seeing tours and friendly visits. All the dele-



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- Hayes E. Martin, M D, of New York City
 Treatment of Teratoma Testis by Roentgen Rays, by R S Ferguson, M D, and Harry Hauser, M D, of New York City
 The Treatment of Mammary Carcinoma with Roentgen Rays, Using Small Daily Doses through Several Ports, by Frank E Adair, M D, of New York City
 High Voltage Cathode Rays, by T E Allibone, of Manchester England
 The Comparative Effect of Very Hard X-rays and Gamma Rays, by Daniel Den Hoed, of Amsterdam, Holland
 Irradiation of Chick Tissues *in Vitro* and *in Ovo*, by C W Wilson, F G Spear, A F W Hughes, and A Glucksmann, of Cambridge, England
 The Reactions of Normal and Pathological Tissues to Teleradium Therapy, by Max Cutler, M D, of Chicago
 The Distinction between X-rays of Different Origin, by Lauriston S Taylor, of Washington, D C
 Back-scattering as a Function of Quality of Radiation, by Edith H Qumby, C F De Lucas, and A N Arneson, of New York City
 The Luminescent Properties of Zinc Sulphide in Relation to X-rays, by Leonard Levy and Donald West, of London, England
 The Small Ionization Chamber, by Otto Glasser, Ph D, and U V Portmann, M D, of Cleveland, Ohio
 Comparison between Teleradium and Deep X-rays, by W V Mayneord, of London
 Measurements of High Voltage X-rays and Gamma Rays in Roentgens, by W V Mayneord and J E Roberts, of London
 A Spectrographic Method of Measuring Voltage Wave Form of a Roentgen Tube, by R R Newell, M D, of San Francisco California
 X-ray Cinematography, by Russel J Reynolds, of London
 Radiotherapy at 700 K V, by G Failla, D Sc, of New York City
 The Therapeutic and Economic Phases of Higher Voltage X-rays, by Albert Soiland, M D, of Los Angeles, California

At the next International Congress, the Fifth, to be held in Chicago, in 1937, there will doubtless be a preponderating share of papers in the English language, the great value of which to North American radiologists can be foreseen. Though the number this year was not great, its value is beyond measure.

ANNOUNCEMENT

NEXT ANNUAL MEETING

Memphis, Monday, Dec 3—Friday, Dec 7

PRELIMINARY REPORT OF SPORTS COMMITTEE

Memphis, down in Dixie—the city where play is business and business is pastime. Just twelve miles to Mississippi, where the magnolias pour forth their fragrant odor all spring and summer and where the wild ducks and geese play all winter. Over the river is Arkansas, where the cotton grows, the negro hums, and the corn boils.

There are nine golf courses at one's service, three country clubs, three municipal and three semi-private courses—all bid you a hearty welcome. Bring along your trusty niblick. The weather is usually fine for outdoor sports in early December.

Tennis a-plenty—Memphis and Chickasaw Country clubs and the University Club have excellent courts. If you do not like our racket, bring your own.

There are quail on the hillsides, ducks in the marshes and rice fields, geese on the sand-bars, and turkey and deer in the densely wooded areas. If you get pleasure from the wilds, bring along your old reliable double barrel and a pair of boots (the diamond backs and copper heads may not all be sleeping for winter).

North a short drive is our famous Reel Foot Lake, south are Moon and Horn lakes, and southwest is Horseshoe Lake. More fish of all varieties can be caught than one needs in one day. Don't forget your rod.

The Mississippi affords a wonderful place for boating, provided the waves are not too high.

Horseback riding astride Tennessee thoroughbreds is a real sport and all you need is a cushion for the next day.

Should the weather prevent the outdoor sports, there is a plenty of handball and bowling for recreation and exercise.

All of the above sports are available and you are welcome. Should you desire a hunting or fishing trip, write to the Committee in advance so that arrangements may be made for you.

W R BETHEA, M D, *Chairman*
 W A RUNKLE, M D
 W D ANDERSON, M D

gates with whom your scribe could converse in ordinary English, fair Scandinavian, worse German, and impossible French and Spanish promised their whole-hearted support to the Fifth International Congress of Radiology in Chicago, Illinois, U S A, during the first two weeks of September, 1937. The log of Secretary-General Walther when last inspected had listed 1,234 foreign members and 50 Americans, a total of 1,284

ALBERT SOILAND, M D

NOTES CONCERNING THE INTERNATIONAL CONGRESS AT ZURICH

As one examines the program of the Fourth International Congress which closed the last of July in Zurich, Switzerland, one cannot but be impressed with the names of the leaders in the science which appear therein. The general information section of the program is printed in French, German, and English. American readers are particularly interested in the papers by English-speaking members of the Congress. The following are among those so listed:

Radiotherapy of Cancers of the Buccal Cavity and Pharynx, by N S Finzi, of London

The Treatment of Cancer of the Mouth by Surface and Interstitial Irradiation, by George E Pfahler, M D, of Philadelphia

Radiation Genetics, by H J Muller, Ph D, of Austin, Texas

The Suitability of the Roentgen as a Unit of Gamma-ray Quantity or Dose, by G W C Kaye, of London

Wilhelm Conrad Röntgen, by Otto Glasser, Ph D, of Cleveland, Ohio

Safety in Screen Examinations, by A E Barclay, of Cambridge, England

Schuller's Disease, a Reticulo-endotheliosis, by Woodburn Morison, of London

Sinus Diagnosis, by Edwin C Ernst, M D, of St Louis Mo

The Roentgen Study of Detachment of Semilunar Cartilages, by W Edward Chamberlain, M D, of Philadelphia

Kymophonoradiography, by I Seth Hirsch, M D, of New York City

Anomalies of the Colon. Their Roentgen Diagnosis and Clinical Significance. Résumé of Ten Years' Study, by John L Kantor, M D, of New York City

Errors in Cholecystography and How to Avoid Them, by James T Case, M D, of Chicago

Sources of Error in Oral Cholecystography, by

William H Stewart, M D, and H Earl Lick, M D, of New York City

Some of the Difficulties in the Interpretation of Cholecystograms, by Cassie B Rose, M D, of Chicago

The Mesentery. A Radiologic Study, by Raphael Pomeranz, M D, of Newark, New Jersey

High Voltage X-radiation of Syringomyelia, by Frederick W O'Brien, M D, of Boston

A Recent Addition to the Organizations of Great Britain for Treating Cancer, by J C McLennan, of London

Principles in the Construction of Cancer Statistics Showing the Result of Treatment, by Arthur B Smallmann, of London

Study of Cancer in Egypt from the Statistical, Social, and Radiotherapeutic Points of View, by Mahmoud Afifi, of Alexandria, Egypt

Changes in the Lungs and Pleura Following Roentgen Treatment of Cancer of the Breast by Intensive Fractional Method, by Harry McIntosh, M D, of New York City

Further Experience in the Value of Pre-operative Irradiation with the X-ray or Radium

and Pre- and Post-biopsy Irradiation when Submitting the Pathological Sections to Number of Experienced Pathologists, by Joseph C Bloodgood, M D, of Baltimore

Three and One-half Years of Experience with 600 to 900 K V (Peak) of Prostatic and Rectal Malignancy, by Seeley G Mudd, M D, and C K Emery, M D, of Pasadena, California

Conservative Methods in the Treatment of Cervical Lymphatics in Intraoral Carcinoma, by James J Duffy, M D, of New York City

Present Methods of Treating Neck Metastases at the State Institute for the Study of Malignant Diseases, by Burton T Simpson, M D, of Buffalo, New York

A Modified Coutard Method for Treatment of Cancer of the Upper Air Passages, by Maurice Lenz, M D, of New York City

Protracted External Irradiation in the Treatment of Neoplasms of the Upper Respiratory Tract. A Comparison of X rays, Five-gram Radium Pack, and One Hundred-milligram Radium Pack, by Milton Friedman, M D, and Rieva Rosh, M D, of New York City

The Treatment of Cancer of the Pharynx, Tonsil, Antrum, and Extrinsic Larynx by Divided Doses of External Irradiation, by

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 HANS W HEFKE, M D, of Milwaukee Wis
 HANS A JARRE M D of Detroit, Mich

DAVIS H PARDOLL, M D, of Chicago
 ERNST A POHLE M D, Ph D, of Madison Wis
 CHARLES G SUTHERLAND, M D, of Rochester, Minn

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BOOK REVIEWS

THE BIOLOGIC EFFECTS OF RADIATION
GAETANO VIALE, Professor of Physiology at the Royal University of Geneva. A volume of 368 pages, with 50 illustrations and 2 colored tables. Published by Fratelli Treves, Milan, Italy, 1934. Price, cloth, 10 lire.

This is another of the "Monographs and Treatises of Biology and Medicine" series, edited by Prof. Carlo Foa, and is more or less a complementary volume to Perussia and Pugno Vanoni's book, "Treatise of Roentgen and Radium Therapy," for in it Viale takes up all the electromagnetic radiations which are the basis for photo- and actinotherapy. Radiologists, biologists, and physiologists will find in this book an excellent presentation of the radiations in Nature (pp 1-10), the solar spectrum and the biologic effects of sunlight (pp 11-43), the principles of photochemistry (pp 46-63), the effects of light on the organism as a whole (pp 64-98), on micro-organisms, plants, and the lower animals (pp 99-128), and then their action on man and the higher animals (pp 129-213), the action of infra-red rays (pp 214-218), polarized light (pp 219-221), the mitogenetic radiations (pp 222-242), bio-radio-activity (pp 243-266), cosmic rays (pp 267-271), photodynamic phenomena (pp 272-300), pigmentation (pp 301-318), diseases due to light (pp 319-328), the principles of phototherapy (pp 329-344), and finally the mechanism of the action of light (pp 345-348), a truly complete presentation.

RADIOLOGY OF THE GALL-BLADDER. AN ANATOMIC, FUNCTIONAL, AND CLINICAL STUDY
By NEMOURS-AUGUSTE, radiologist of the Paul Brousse Hospital. Preface by Professor Roussey. A volume of 186 pages with 102 illustrations and 27 *planches hors texte*. Published by Masson et Cie, Paris, 1934. Price, 45 francs.

The last ten years have witnessed the ripening of a most remarkable advance in the diag-

nostics of internal medicine. The perfection of cholecystography by Graham has opened up a wide field of investigation of gall bladder disease and many of its complications. Also, monographs on the subject have appeared, not only in English but in other languages, including French, German, and Spanish. This new work by Nemours-Auguste is a very complete treatise on the radiologic investigation of the gall-bladder, both with and without the aid of cholecystography. The relation of the gall bladder to the duodenum and the hepatic flexure is included in the discussion. The book contains chapters on the following subjects: extrahepatic biliary passage, the known functions of the gall bladder in relation to the roentgenologic examination, the preparation of the patient and the technic of the injection or oral administration, the roentgenographic technic, a complete discussion of the normal gall-bladder, and of chronic gall bladder disease, including cholelithiasis, pericholecystitis, and cancer of the gall-bladder. A chapter is devoted to the indirect roentgenologic signs of cholecystitis. The final chapter deals with the alleged lack of agreement between the clinical and the radiologic findings. Clinicians are sometimes astonished to find that a diseased gall-bladder, with or without stones, can be filled by the "tetraiod," and become visible to the x-rays, and to find the same appearance in a gall-bladder which would be called by them "normal" on a single film.

After considerable discussion, the author concludes that the discord is more apparent than real and arises from incomplete or faulty interpretation of the cholecystograms. It should be recognized that a good roentgen diagnosis depends on perfection of technic and the recognition of the recent researches in the physiology of the biliary passage. Failure in either regard may result in error. There is nothing outstandingly new in this volume, but it may be said of it that it constitutes an excellent presentation of the subject.

Abstracts of Current Literature

THE APPENDIX

The Value of the Contrast Enema for the Demonstration of the Appendix S Kadrnka Röntgenpraxis, February, 1934 6, 73-84

Appendices to the number of 400 were roentgenologically examined by the barium enema method The observation of Berg and Knothe, that the filling of the appendix takes place only after the patient has expelled the enema, is confirmed The appendix is filled by the enema method as often as by any of the modified oral methods The advantage of the former lies in the saving of time and films, and the entire colon may be adequately examined which is not possible with any of the oral methods A disadvantage is the non filling of the appendix in obstinate atony of the cecum, and in coprostasis In these cases filling of the appendix by the oral administration of a barium-epsom salt mixture seems to give better results The non-filling of the appendix, provided the correct technic has been used, is the most important roentgenologic symptom of a pathologic appendix and is correct in 90.7 per cent of the cases (checked by surgery) The non filling appendix might be compared with the non functioning gall bladder The enema method has taken the place of the oral method in the author's clinic

HANS W HEFKE M.D

ARTHRITIS

Peri arthritis Humero-radialis K Staunig Fortschr a d Geb d Röntgenstrahlen, 1934 49, 90-92

Several patients presented themselves with complaints of pain in the elbow which occurred suddenly on lifting limitation of motion, slight swelling over the lateral parts of the joint localized and intense pain on pressure over the radial capitellum One case is reported with very severe symptoms of this type but, while all previous cases showed no roentgenologic pathology, incrustations were demonstrated in this last case in the humero-radial joint capsule An unusually marked degree of peri arthritis 'humero radialis' is assumed, similar to peri arthritis humero-scapularis

The opinion is expressed that these manifestations belong to arthritic diathesis and that mechanical and static conditions at various joints are responsible for varying demonstrable 'arthritic' changes—erosions and destructions of articular surfaces, when pressure is to be borne, capsular changes when tension is applied

H A JARRE, M.D

BIOLOGIC EFFECTS

The Problem of Dosage in Ultra short Wave Therapy E Hasché and H Leuning Strahlentherapie, 1934, 50, 351-356

The authors studied the effect of short electric waves (8-16 meters) on staphylococci kept in distilled water, physiological NaCl₂ solution, in broth, and on streptococci in milk Their experiments did not show any definite effects of the electric waves on the biological material They emphasize, however, that in spite of these negative experiments *in vitro* there is no doubt as to the remarkable clinical results produced by these waves in inflammatory processes

ERNST A POHLE, M.D., Ph.D

BLOOD CHANGES

Results of Experimental Studies in the Peripheral White Blood Picture Following Roentgen Irradiation E Hayer Strahlentherapie, 1934, 50, 193-236

The author studied changes in the white blood picture in the peripheral blood of dogs following exposure to roentgen rays Heavily filtered radiation was used 180 K.V., 0.5 mm Cu H.V.L. in Cu, 0.9 mm, field sizes 8 × 10 and 10 × 15 F.S.D. 75 cm, varying doses from 300 to 600 r Very detailed studies of the differential count were made, the blood oxidase was followed over a period of several weeks, and a functional test was also used The latter consisted of the injection of turpentine in order to produce a sterile abscess, followed by a study of the leukocyte picture If a small volume of tissue in the upper thigh was irradiated, the lymphocytes dropped first, followed by an increase of short duration If an abscess was produced after the exposure, it took the same course as in untreated controls Following exposure of the spleen there was a definite decrease in all leukocytes lasting for several weeks The characteristic changes in the white blood picture after producing an artificial abscess were the same as in the other dogs The formation of the abscess was sometimes slightly delayed In general, it appears that, following local exposure the changes in the white blood picture depend largely on the irradiated tissue volume If the entire body of the animal is irradiated there is a marked drop in all leukocytes lasting for weeks, all types of leukocytes participate in this reaction The injuries to the organism are so pronounced that the usual reactions observed in the blood picture following injection of turpentine do not occur Following local exposure the oxidase is increased, while following total body exposure to 600 r it is definitely decreased No systemic effect of the exposure could be seen following local treatment After total body exposure the animals appear rather weak for two or three days, do not eat and lose weight All ten dogs were alive and well ten weeks after the exposures

ERNST A POHLE, M.D., Ph.D

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about 1 per cent increase in calcium and a slighter increase in phosphorus although the phosphorus content of the blood is more frankly increased. Consanguinity seems to play an important part in the occurrence of the disease.

J E HABBE, M D

Parathyroidism—Its Clinical Symptomatology
Max Ballin. *Am Jour Roentgenol and Rad Ther*, November, 1933, 30, 571-577

According to the author the time has arrived to discontinue presenting such conditions as giant-cell tumor, bone cyst and osteitis fibrosa cystica as separate entities—they should rather all be considered under the single term 'parathyroidism'. The use of the single term 'parathyroidism' will lead not only to a better understanding of etiology but also of the proper treatment.

It should, of course, be understood that other endocrine disturbances cause skeletal changes recognizable roentgenologically, as, for example, thyroidism causing disturbances in calcium deposition and certain forms of arthritis pituitarism (basophil adenoma of pituitary) with skeletal changes at times, xanthomatosis—a disturbance of lipid metabolism and certain splenic disorders in children with skeletal changes.

It is a well established fact that when the parathyroids are irritated by hyperplasia or by an adenoma, a hypercalcemia occurs, calcium being removed from the skeleton. It has also been shown repeatedly that the removal of the adenomatous parathyroid effects a cure of the skeletal disturbance.

The hereditary factor is considered important in explaining the occurrence of parathyroidism. Diet may also be a factor in contributing both to the development and control of this condition. In a group of 10 cases on record the onset followed early surgical menopause.

Concerning symptoms, the pain usually begins in the hips and radiates down the legs later being experienced in other bones. In older individuals bowing deformities are not uncommon, and there is a rather marked muscular weakness.

An important pathologic change, often recognizable roentgenologically, is in the nature of secondary calcium deposits from the overloaded blood stream along the vertebral ligaments in the intervertebral discs, in blood vessel walls and usually visible microscopically only in the liver, spleen, intestinal mucosa, and kidneys.

Entirely negative roentgen findings (and gross appearances of the bones at postmortem) may occasionally be encountered yet microscopically widespread skeletal changes are present. Similarly only a single bone may show roentgenologically a decalcification as for example the so-called monostotic Page's, yet pathologically the changes are extensive. Laboratory findings of hypercalcemia and hypophosphatemia may occasionally be absent temporarily.

The real case of parathyroidism in contrast to the temporary parathyroid disturbances of late rickets

osteomalacia, or vitamin insufficiencies, does not respond to ultra violet rays, vitamin feeding, or calcium and parathyroid administration. In fact, the true cases are made worse. Radiation treatment in hyperplastic cases is rational but not always effective. Surgical removal of the adenoma or of hyperplastic tissue is often lifesaving and may return the patient to normal. Recalcification after operation has been observed as early as the sixth week, bone cysts and giant-cell tumors solidify, and bone pain is promptly relieved.

J E HABBE, M D

Osteomalacia. A Brief Review of the Modern Conception of the Disease. Paul C. Hodges and Alfred C. Ledoux. *Am Jour Roentgenol and Rad Ther*, November, 1933, 30, 590-595.

Osteomalacia is primarily a disease manifestation of Vitamin D deficiency, yet it may be considered to be the manifestation of rickets in the adult. It is a disease rarely encountered in this country (observed most often in pregnant or lactating women), but is said to be common in India and China where ignorance and religious custom require women to be confined to dark quarters on an inadequate diet.

Clinically, there is pelvic pain ranging from mild to intense gait may be waddling or entirely impossible, calcium and phosphorus content of the blood is usually disturbed, roentgen examination reveals alteration in the appearance of the spine, pelvis, femora, and sometimes other long bones. The cortex of the bone is paper thin, the trabeculae appear as a faint network. Multiple fractures of the pelvic bones are common. The treatment is plenty of sunshine and an adequate diet, particularly full in Vitamin D.

J E HABBE, M D

CALCULI

Sialolithiasis. Paul W. Greeley. *Jour Am Med Assn*, June 23, 1934, 102, 2078-2081.

Harrison found 375 reported cases in the literature from 1825 to 1926 and added 27 of his own. The stones are usually single, but one author reported the removal of fourteen from one gland and its duct. Stones weighing as much as 236 gm. have been reported, while this particular calculus measured $1\frac{3}{4}$ by 1 by $\frac{1}{2}$ inch. These concretions may vary from the size of a millet seed to that of a walnut. One case was reported in an infant less than one month old. The calculi are more common in males than in females. In about 75 per cent of all cases the stones were in the submaxillary ducts or glands, about 20 per cent in the parotid, and a small number in the sublingual duct or glands. Badanes believes that three principal substances contribute to their formation, namely, calcium oxalate, globulin and mucin. Calcium carbonate and phosphate stones are sometimes formed around a foreign body nucleus.

BONE DISEASES (DIAGNOSIS)

Ankylosing Spondylitis and Polyarthritis (Bechterew, Strümpell Marie and Related Types) E Walter Hall Am Jour Roentgenol and Rad Ther, November, 1933 30, 608-614

Emphasis is given to the belief that all forms of multiple spondylarthritis are manifestations of a systemic disease, with trauma occupational posture, strain and pre-existing local infection varying in importance in individual cases. The Bechterew, or hypertrophic type of spondylarthritis (slowly developing type) is considered the result of an underlying hereditary tendency, with trauma as the exciting cause, while the Strümpell-Marie or atrophic type (rapidly progressing form) is probably of toxic or disturbed nutrition origin. In each type there is more or less demineralization of the bones while calcium is laid down in the soft tissues particularly the paraspinal ligaments. The Bechterew type progresses slowly and the patient is not incapacitated, hence strain and mobility are continued as a result of which, together with well recognized hypotonicity of the back muscles there is kyphotic bowing of the dorsal segment and pressure atrophy of intervertebral discs, with osteophyte formation beginning at the anterior margins of the vertebral bodies. These two effects of muscle hypotonicity and calcium metastasis may be related to parathyroidism. In the Marie-Strümpell type, being rapidly progressive, there is insufficient time for spinal deformity before ligamentous calcification produces immobilization of the spine. The possibility of toxins acting as a stimulant of the parathyroids to over-activity is suggested particularly in the Marie-Strümpell type of involvement.

It has been found that in some cases of ankylosing polyarthritis with muscular hypotonus, stiffness and pain parathyroidectomy has given early relief of pain and stopped progress of the calcium metastases

J E HABBE M D

Morquio's Disease Report of Two Cases David B Davis and Fred P Currier Jour Am Med Assn June 30 1934 102, 2173-2176

The authors report two cases and review the literature on the subject. Morquio, of Montevideo in 1929 reported a peculiar form of familial osseous dystrophy, occurring in four children of five of the same family. The children developed normally during the first year, the bony changes appeared about the time they commenced to walk sparing only the head and face and causing no pain or other suffering but functional troubles affecting especially motility and physical trouble destroying the harmony of the body. The deformities are symmetrical, the extremities are of normal length though deformed and the thorax is reduced in length and broadened.

Roentgenograms showed delayed epiphyseal development and distortion of the shaft of the phalanges metacarpals and metaphyseal ends of the bones of the arm and forearm. The phalanges were thickened and their trabeculae were irregular and distorted. There were

irregular areas of decreased density near the metaphyses. The cranial vault was large, with a thin wall and showed no increase in digital markings. The anterior wall of the sella was imperfectly developed. The bridge of the nose was sunken. The head was scaphocephalic, the jaw bone was larger than normal and out of proportion to the skull. The anteroposterior diameter of the chest was increased. The spine was straight showing a lack of normal curvature and presented areas of exuberance.

Morquio stated that the face and head were not involved. Meyer and Brennemann noted that the head was large, Ruggles stated that the head was large eyes wide spaced and the root of the nose depressed. Optic atrophy, with resulting blindness, is usually seen in the later stages.

Morquio is the only writer who noted marked abnormality in the blood chemistry. He believed the disturbance of osteogenesis could be explained by the low calcium content of the blood.

The condition has some of the characteristics of achondroplasia, but there are certain changes that cannot be explained entirely on this basis.

CHARLES G SUTHERLAND M D

Osteopoikilosis Leslie F Wilcox Am Jour Roentgenol and Rad Ther, November, 1933, 30, 615-617

This condition is a hereditary anomaly developing from a congenital cartilage anlage, and should be grouped with the dyschondroplasias. The author's two cases occurred in father and son, the latter being 21 years old at the time of the roentgen study. No cases reported in the literature had any symptoms which were referable to the bone changes. Similarly the blood calcium and blood phosphorus have always been found to be normal. Three types of this anomaly of bone development are described as follows: (1) the spotted (common) form, (2) the striated (rare) form, and (3) the combined forms. In all cases the areas of bone condensation which vary from two millimeters in diameter to several centimeters in length are always found in the epiphyses and metaphyses, never in the mid portions of the diaphyses. They follow a longitudinal arrangement. The skull bones are never involved.

J E HABBE M D

Marble Bones A Howard Price Am Jour Roentgenol and Rad Ther November 1933, 30, 618-620

Marble bones is a rare condition characterized by the transformation of the spongy parts of the bone into solid compact tissue. In the early stage the carpal and tarsal bones vertebrae and iliac bones show marginal bands of increased density. Osteoporosis is the antecedent stage to the sclerosis of marble bones. Pathologic (true transverse non-committed) fractures are common but healing by adequate callus occurs promptly. Chemical analysis of the bone shows only

about 1 per cent increase in calcium and a slighter increase in phosphorus although the phosphorus content of the blood is more frankly increased. Consanguinity seems to play an important part in the occurrence of the disease.

J E HABBE, M D

Parathyroidism—Its Clinical Symptomatology
Max Ballin. *Am Jour Roentgenol and Rad Ther*, November, 1933 30, 571-577

According to the author the time has arrived to discontinue presenting such conditions as giant-cell tumor, bone cyst, and osteitis fibrosa cystica as separate entities. They should rather all be considered under the single term 'parathyroidism'. The use of the single term parathyroidism will lead not only to a better understanding of etiology but also of the proper treatment.

It should, of course, be understood that other endocrine disturbances cause skeletal changes recognizable roentgenologically, as for example thyroidism causing disturbances in calcium deposition and certain forms of arthritis, pituitarism (basophil adenoma of pituitary) with skeletal changes at times, xanthomatosis, a disturbance of lipid metabolism, and certain splenic disorders in children with skeletal changes.

It is a well established fact that when the parathyroids are irritated by hyperplasia or by an adenoma, a hypercalcemia occurs, calcium being removed from the skeleton. It has also been shown repeatedly that the removal of the adenomatous parathyroid effects a cure of the skeletal disturbance.

The hereditary factor is considered important in explaining the occurrence of parathyroidism. Diet may also be a factor in contributing both to the development and control of this condition. In a group of 10 cases on record the onset followed early surgical menopause.

Concerning symptoms, the pain usually begins in the hips and radiates down the legs, later being experienced in other bones. In older individuals bowing deformities are not uncommon and there is a rather marked muscular weakness.

An important pathologic change, often recognizable roentgenologically, is in the nature of secondary calcium deposits from the overloaded blood stream along the vertebral ligaments in the intervertebral discs, in blood vessel walls and usually visible microscopically only in the liver, spleen, intestinal mucosa and kidneys.

Entirely negative roentgen findings (and gross appearances of the bones at postmortem) may occasionally be encountered, yet microscopically widespread skeletal changes are present. Similarly only a single bone may show roentgenologically a decalcification as, for example, the so-called monostotic Page's, yet pathologically the changes are extensive. Laboratory findings of hypercalcemia and hypophosphatemia may occasionally be absent temporarily.

The real case of parathyroidism in contrast to the temporary parathyroid disturbances of late rickets

osteomalacia, or vitamin insufficiencies does not respond to ultra violet rays, vitamin feeding, or calcium and parathyroid administration. In fact, the true cases are made worse. Radiation treatment in hyperplastic cases is rational but not always effective. Surgical removal of the adenoma or of hyperplastic tissue is often lifesaving and may return the patient to normal. Recalcification after operation has been observed as early as the sixth week, bone cysts and giant-cell tumors solidify, and bone pain is promptly relieved.

J E HABBE, M D

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J E HABBE, M D

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Hamlin believes that negative roentgenographic findings are often the result of faulty technique. A calculus in the anterior two thirds of Wharton's duct can readily be demonstrated by using a $2\frac{1}{2}$ by $3\frac{1}{2}$ inch film, placed horizontally between the teeth as far back in the mouth as possible, and by directing the rays from beneath the chin upward. A calculus in the posterior third of the gland itself will be best shown by taking a lateral view. The anterior two thirds of the duct cannot be demonstrated by a lateral film because the duct will be obscured by the shadow of the mandible. Those in Stenson's duct can usually be shown on a small film held over the outside of the duct and parotid gland on the cheek.

The differential diagnosis is discussed in detail. Salivary calculi may recur, recurrences after operative removal are noted most frequently in the submaxillary and sublingual glands and ducts. The period between operative removal and recurrence has been noted to vary from a few months to five years. A recurrent attack may be due to (1) failure to recognize concretions of the excretory ducts of the salivary glands at operation during which these are often forced into the ducts, (2) breaking of the calculus during removal, and (3) transitory or permanent cicatrization of the salivary passages after removal of a stone without simultaneous extirpation of the gland. The universal pre operative use of roentgenography should localize and identify these calculi accurately so that all can be removed at operation. Treatment may be medical or surgical or a combination of the two.

CHARLES G. SUTHERLAND, M.D.

CHEST ROENTGENOGRAPHY

The Interpretation of the Triangular Basal Shadows in Roentgenograms of the Chest. G. E. Richards. *Am Jour Roentgenol and Rad Ther*, September, 1933 30, 289-295.

The term triangular basal shadow is used by the author to designate an abnormal density occurring in either side of the lower chest, which renders obtuse the cardio diaphragmatic angle, its lateral border being straight or slightly curved. On the left side it may be more or less obscured by the heart shadow. This shadow has been observed by the author in 10 instances out of 2 000 consecutive routine chest examinations and is attributed to an atelectatic lower lobe, a phase of bronchiectasis. By intratracheal injection of lipiodol into the side of the chest showing the triangular density, one may regularly demonstrate the bronchiectatic cavities. A whole lower lobe may be represented by the triangular shadow, the atelectasis being associated with rather marked downward rotation of the involved bronchi. However, according to others who have investigated the same subject, it is probable that most of these cases occur in individuals presenting anomalous development of the lungs in the form of an accessory inferior lobe, the pathology then being limited to the accessory lobe.

J. E. HABBE, M.D.

CONTRAST MEDIA

A Contribution to Brain Arteriography. Otto Dyes. *Röntgenpraxis*, February, 1934, 6, 93-95.

The demonstration of pathologic changes of the vessels of the brain by the injection of contrast media is not only of value in diseases which lead secondarily to their displacement, but is important also in diseases of the arteries themselves. In the author's case a small piece of a gunshell was found in the region of the second cervical vertebra. The patient complained of weakness in the right arm, disturbance of vision and attacks of aphasia. An arteriogram produced by the injection of thorotrast in the left internal carotid showed an aneurysm in the proximity of the foreign body, the anterior cerebral artery could not be visualized, apparently because of embolic occlusion. An encephalogram showed atrophy of the brain and some enlargement of the anterior left ventricle. The roentgenologic examination was of great help in establishing the connection between the foreign body and the neurological symptoms.

HANS W. HEFKE, M.D.

THE ESOPHAGUS (DIAGNOSIS)

The Congenitally Short Esophagus. Louis H. Clerf and Willis F. Manges. *Jour Am Med Assn*, June 16, 1934, 102, 2008-2012.

Atresia of the esophagus with an esophagotracheal fistula has long been considered the most common congenital anomaly of this structure. Congenital stenosis is more common than personal records or reports in the literature by esophagoscopists would indicate. It may not produce symptoms until solid food is eaten, in some cases symptoms of obstruction may not occur until adult life has been reached. The scarcity of reports of these cases in the literature should not indicate that the condition is rare. The authors have seen 14 cases within four years, all other data pertaining to this anomaly have appeared in the British medical literature.

No classic symptom group has been suggested. One can divide the cases into two groups. In one the outstanding symptoms are dysphagia and regurgitation with disturbances in nutrition and growth. In the other group distress particularly after eating has been noted in addition to dysphagia with lodgment of food and regurgitation. Certain cases are symptom free until dietetic indiscretions result in the lodgment of food or the development of pathologic lesions direct attention to the esophagus. Careful investigation will often reveal that dysphagia has been present since birth or more commonly since solid food has been added to the dietary.

Weight loss was particularly noticeable in the children, all of whom were underweight and poorly developed. Symptoms varying from indigestion and flatulence to severe epigastric pain were present in seven adults and one child. These occurred shortly after taking food. Severe pain was a prominent symptom in four.

The essential points in the roentgen diagnosis of congenital shortening of the esophagus are First, a portion of the cardiac end of the stomach must be shown to stay above the level of the diaphragm, second the esophagus must be shown to be too short to reach as low as the level of the diaphragm

CHARLES G SUTHERLAND, M D

Diagnosis and Therapy of Pedunculated Esophageal Tumors Chichio Jamiya and Schuei Nosaki Fortschr a d Geb d Röntgenstrahlen 1934, 49, 481-498

A detailed report of a fibroma of the esophagus of considerable size, diagnosed roentgenologically and esophagoscopically as a benign tumor It was removed through the esophagoscope in several stages A review of the literature is appended, and differential diagnosis

H A JARRE, M D

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Role of the Gastro intestinal Tract in Conditioning Deficiency Disease The Significance of Digestion and Absorption in Pernicious Anemia, Pellagra, and "Alcoholic" and Other Forms of Polyneuritis Maurice B Strauss Jour Am Med Assn, July 7, 1934, 103, 1-4

A new concept is that deficiency disease in man may and frequently does develop because of some disturbance of the gastro intestinal tract in spite of an apparently adequate diet Castle, in 1928, demonstrated clearly that an asymptomatic abnormality of gastric secretion might condition a state of dietary deficiency irrespective of the adequacy of the diet Pernicious anemia, pellagra, alcoholic and pregnancy polyneuritis, idiopathic hypochromic anemia, and the toxemias associated with intestinal obstruction and vomiting in pregnancy, among other conditions, may be due in many instances wholly or in part to deficiencies resulting from disturbances of the gastro intestinal tract

CHARLES G SUTHERLAND, M D

The Incidence of Malignancy in Chronic Pre pyloric Gastric Ulcerations Aubrey O Hampton Am Jour Roentgenol and Rad Ther, October 1933, 30, 473-479

It is well known that the benign or malignant nature of certain gastric ulcerations cannot be determined by cross examination However the localization of such a gastric lesion as determined roentgenologically may offer considerable aid Proven cases of benign gastric ulcer were grouped as to location in the following way pyloric pre pyloric (one inch of the stomach immediately proximal to but not including the pyloric canal), near pylorus and media Proven cases of gastric cancers were grouped according to location as follows pyloric end, media cardia or diffuse It was noted that the incidence of occurrence of malignant lesions

to benign chronic (indurated) ulcers in the pre-pyloric segment was as 12 is to 1 In those relatively infrequent cases diagnosed clinically and roentgenologically as benign pre-pyloric ulcer, a follow-up of eight cases showed all returning within an average time of two years as advanced carcinomas of the stomach Hence it is the conclusion of the author that all lesions presenting the appearance of chronic pre pyloric ulcerations should be treated as malignant

J E HABBE, M D

Chronic Disturbances of Motility in the Duodenum Zoltan v Alföldy Röntgenpraxis, May, 1934, 6, 282-287

Chronic duodenal stenosis and megaduodenum should be differentiated In megaduodenum, other constitutional anomalies are present as megalcolon, an abnormally wide jejunum, an abnormal position of the duodenal jejunal junction and others In the cases of duodenal stenosis there must be a mechanical cause for the complete or partial obstruction The roentgen signs of a stenosis are, according to Holzknecht dilatation of the duodenum, stenotic peristalsis and a duodenal residue after six hours There have been some cases of duodenal stenosis described during the last few years in which no anatomical explanation could be found at operation The nervous system might be responsible for this symptom-complex in some of these cases

The author's patient, a woman complaining of indigestion and nausea, had an enormously dilated duodenum at the roentgenologic examination, especially in the descending and horizontal portions The peristalsis was hyperactive eight hours after the barium meal there was still some barium in the duodenum while the stomach was empty At operation the dilatation was very evident but no adequate reason for obstruction could be found A posterior gastroenterostomy was done, which did not function well for two weeks because of a vicious circle It is the author's belief that fine adhesions between the duodenum and the gall bladder, found at operation, might have led to a reflex stenosis in the neuropathic patient

HANS W HEFKE M D

HEART AND VASCULAR SYSTEM

Kymographic Analysis of the Movements of the Heart P Stumpf Fortschr a d Geb d Röntgenstrahlen March, 1934, 49, 211-224

Analysis of planikymograms of the heart, refined by densography, is hardly inferior to other polygraphic diagnostic curves of the circulatory system

Investigation of the movements of various cardiac segments in relation to those of the aorta led to these conclusions

(1) Medial excursion of the left ventricle does not necessarily coincide with the whole period of systole, its start fluctuates widely During systole marked medial excursions are noted quite regularly, but their

start and termination may show pronounced lag in various ventricular segments

(2) Movements in the region of the left auricular appendix are quite variable though usually two peaks and two troughs are recognized

(3) Three components are usually observed in the movements of the right cardiac border, their influence at different levels fluctuates widely, so that at times excursions in opposing direction may be found simultaneously in cranial as compared to caudal segments. The old problem as to the margin forming part of the right cardiac border cannot be solved by most detailed analysis

Transitions of excursions along the cardiac borders take place quite gradually so that one may recognize in adjacent segments influences of different efforts

In the first oblique diameter it was possible to demonstrate different movements of the anterior and posterior aortic wall because dilatation and change in position produce additive effects along the anterior and lateral margins, subtractive effects on the posterior margin at certain phases, thus the movements may appear disrupted. With increasing frequency of pulsations there occurs no reduction of the duration of the contraction during the expulsive phase. Duration and amplitude of excursions of the left cardiac margin cannot be used for evaluation of cardiac competency and sufficiency. They may be used though for recognition of the distribution of the movements which observation might be more adaptable to pathologic and anatomic viewpoints. Kymography is an excellent addition to electrocardiography, but never will replace it and should not be compared to it

HANS A. JARRE, M.D.

Calcification in Aortic and Mitral Valves with a Report of 23 Cases Demonstrated *in vivo* by the Roentgen Ray. Merrill C. Sosman and Paul H. Wosika. *Am Jour Roentgenol and Rad Ther* September 1933, 30, 328-348

When there is marked calcification in the heart valves it should be rather easily possible for anyone experienced in roentgenoscopy to visualize the same if he understands where and how to look for it. To show even advanced calcification convincingly by means of roentgen examination requires special methods using high power equipment and rapid exposure technic (1/20 second or faster). The authors first case found roentgenoscopically was reported in 1924. The first case of aortic stenosis with calcification recognized *in vivo* to be reported in the literature was by Christian in 1931. Pericardial calcification had first been demonstrated *in vivo* and reported by Klason in 1922.

Concerning aortic calcification in the 12 cases (9 males and 3 females) reported by the authors the average age was 53 years, half gave a history of preceding rheumatic fever, two thirds were aware of heart trouble seven being hospital patients. 10 with a

systolic basal thrill, and 11 with a harsh systolic basal murmur, 11 showed cardiac enlargement, and all but one showed calcification roentgenologically.

In the mitral group, comprising 13 cases (8 males and 5 females) half gave a previous history of rheumatic fever (11 to 36 years prior to discovery of calcification). All but one were aware of the presence of heart disease (7 patients were fibrillating, a diastolic and systolic murmur was heard at the apex in the nine youngest cardiac enlargement was present in 12, the blood pressure in general was low, and calcification of the mitral valve was demonstrated roentgenologically in all cases).

In these cases syphilis did not seem to be a factor in causing the calcification whereas past rheumatic fever was looked upon as an important factor although the Mönckeberg theory is against the inflammation theory and in favor of degeneration of the media of the aortic wall with extension of calcification to the valve walls.

Concerning roentgenoscopic visualization, adequate preparation of the eyes and the use of a small diaphragm opening are emphasized the patient being rotated 15 to 20 degrees to the left of the usual postero-anterior position. A dancing movement toward the apex with each systole is observed and this motion is best noted at held inspiration. Most calcified aortic valves are located at the left border of the spine in the anteroposterior view and about midway or just behind the center of the heart substance whereas calcified mitral valves lie well to the left of the spine and are in the posterior third of the heart.

The most confusing shadows are cast by calcification in the costal cartilages or by calcified glands.

Condensed clinical histories of all cases reported are included in the article.

J. E. HABBE, M.D.

Multiple Aneurysms of the Smaller Branches of the Pulmonary Artery. John M. Barnes and Daniel E. Stedem. *Am Jour Roentgenol and Rad Ther* October, 1933, 30, 443-448.

Aneurysms of the pulmonary artery (excluding small vascular dilatations secondary to pulmonary cavitation) are relatively rare, and of these the great majority 85 per cent involve the main trunk and most of the remainder the larger branches. Aneurysms of the terminal branches may be the result of mycotic infection or on the basis of congenital defects.

The case reported here was that of a female aged 50 years who was first seen because of repeated severe epistaxis which began at the age of 39 years. Shortly prior to admission to the hospital she had developed nausea with occasional vomiting and blood in the stools. On admission the physical findings were those of marked anemia and small bilateral pleural effusion. X-ray study of the chest showed rounded shadows in the right upper lung interpreted as probable pulmonary metastases and effusion at both bases.

The patient died of coronary thrombosis a few days after admission and showed at necropsy a large ac

cumulation of blood under pressure in the left pleural cavity. In the left lower lung a mass of clotted blood was found lying in a sac formerly adherent to the diaphragm but with a rent in its side through which the bleeding had undoubtedly occurred. This sac was continuous with a branch of the left pulmonary artery. In the right chest there was no blood but there was found in the upper lung several small pulmonary artery aneurysms, each about 2 cm. in diameter.

In reviewing the films after the postmortem findings had been obtained, the authors observed that the nodular shadows in the right upper lung showed a definite vascular connection with the hilus, and on this basis plus the possible demonstration of pulsation of the densities fluoroscopically conclude that in the future a correct differential diagnosis may be possible.

J. E. HABBE, M.D.

HYPERPARATHYROIDISM

The Differential Diagnosis of Hyperparathyroidism
Alexander B. Gutman, Paul C. Swenson and W. Barclay Parsons. *Jour. Am. Med. Assn.*, July 14, 1934, 103, 87-94.

Four new proved cases are presented. The data in 115 other proved cases in the literature were analyzed to indicate the incidence of initial presenting symptoms and their relative diagnostic significance. The disease occurs more frequently in females (86 females and 29 males) and most frequently in middle life. The course of the disease is usually measured in years, rarely in months. The disease begins most frequently with pain, usually a dull ache in the lower part of the back, legs, or arms, intensified by exercise and often associated with stiffness of the joints. The pain tends to become more diffuse and intense. Bone tenderness, localized at first, is common and may eventually become generalized. Muscle weakness with hypotonia may be so marked as to simulate Addison's disease, myasthenia gravis or progressive muscle dystrophy, when associated with muscle wasting. Localized bone swellings, solitary and painless at first but multiple and tender later on, are most common in the jaws but occur frequently in the tibia, phalanges or elsewhere, particularly after slight trauma. They may appear years before the general symptoms and may be difficult to differentiate pathologically from sarcoma or from focal osteitis fibrosa. Pathologic fractures increase in incidence as decalcification progresses—turning in bed or coughing may result in fracture. Non union and mal union are common. Deformities of all types occur, sometimes with loss of height and bizarre mutilation of the extremities. Disturbances of gait of the waddling type or limp may develop relatively early and become progressively worse.

Polyuria and polydipsia may be so marked as to suggest diabetes insipidus. Renal colic was the predominating symptom in about 10 per cent of the cases. Episodes of intractable nausea and vomiting may appear suddenly and persist for weeks or months. Anorexia and stubborn constipation are common and may

be presenting symptoms. In six cases sharp pain in the abdomen appeared. The gastro intestinal symptoms may so dominate the picture as to suggest duodenal ulcer or acute appendicitis. Weight loss was a major complaint in one-fourth of the cases. Moderate secondary anemia was common. Nervousness, tachycardia and other symptoms have been described. A tumor in the neck could be palpated definitely in less than 10 per cent of the cases.

The outstanding roentgenologic feature is general decalcification of the skeleton, a finely granular appearance of the skull with thickened bone and indistinct tables. In the long bones, thinning of the cortex and the trabeculae, with indistinct, irregular, and fuzzy outlines. Cyst formation may be present in the central portion of the shafts or subperiosteally. The vertebrae show a granular pattern much like the calvarium with an added coarsely striated appearance. The terminal phalanges are often almost completely resorbed. The mineral metabolism is discussed in detail.

CHARLES G. SUTHERLAND, M.D.

THE KNEE JOINT

Relationship between Anatomic Changes in Knee Joint with Advancing Age and Degenerative Arthritis
C. S. Keefer, F. Parker, Jr., W. K. Myers, and R. L. Irwin. *Archiv. Int. Med.*, March, 1934, 53, 325-343.

In a study of 100 knee joints from 77 consecutive patients who died of various diseases, the following facts were determined:

1. Anatomic changes were noted with increasing frequency with advancing age.

2. The patella showed alterations in 81 per cent of the cases, the interpatellar groove in 65 per cent, the lateral condyle of the tibia in 64 per cent, the medial condyle of the tibia in 55 per cent, the medial condyle of the femur in 43 per cent, and the lateral condyle in 36 per cent.

3. The erosions were commonest over the areas of contact which were subjected to the greatest movement, strain, weight-bearing, and injury.

4. The changes were identical in males and females, and there was no relationship between the extent of the lesions in the joints and the symptoms referable to the joints.

5. There was no correlation between the lesions in the joints and the degree of arteriosclerosis or any other particular type of disease process.

6. The gross anatomic changes were indistinguishable from those previously described in degenerative arthritis.

7. The various factors which are of importance in the development of degenerative arthritis are discussed. They include the aging of tissue, wear and tear, strain, trauma, occupational and static deformities.

It seems difficult to escape the conclusion that the changes which are seen in the joints with increasing frequency with advancing age are identical with those which have been previously described as characteristic of degenerative arthritis. If this is true, there is justifi-

fication for the belief that degenerative arthritis is a process associated with the aging of the tissues of the joints. This conception is essential for a complete understanding of the pathogenesis of this disorder. Added to the process of involution, such factors as gross trauma, hemorrhage, and static deformities exaggerate the condition. The end result depends on the summation of these factors.

H A JARRE, M D

THE LARYNX

Importance of the Roentgen Examination in Polypoid Tumors of the Larynx. W H McGehee. *Am Jour Roentgenol and Rad Ther*, October, 1933, 30, 464-467.

Five cases of polypoid tumors of the larynx all arising from the anterior wall near the anterior commissure, have been observed by the writer. Four were benign (ages of patients 5, 6, 15, and 19 years) and one was malignant (age of patient, 60 years). X-ray study is particularly helpful in small children and in unco-operative adults, cases in which laryngoscopic study may be unsatisfactory. One may occasionally obtain information by an x ray study which is not obtainable by laryngoscopy even with the full co-operation of the patient.

J E HABBE, M D

THE LIVER

Iodipin-embolism of the Liver. Walter Steffens. *Röntgenpraxis*, February, 1934, 6, 104-106.

The use of iodized oils for roentgenologic examinations is not always harmless. Harmful effects of these oils, when used for injection of fistulas for demonstration of the urethra or uterus and tubes have been reported. The case of a young man is described who had long suffered from a persistent fistula in the left lower anterior thoracic wall, following a gunshot wound. Injection of iodipin into the fistula led to a collapse of the patient and an embolic filling of the vessels of the liver, visible on roentgenograms. The patient recovered in a few hours. Two months later the iodized oil was still visible in roentgenograms of the liver after sixteen months only traces could be seen. It seemed reasonable to explain this accident by the entrance of the contrast material into a vein around the fistula and close to the foreign body from whence it was transported to the liver through the portal vein.

HANS W HEFKE, M D

THE LUNGS

Significance of Roentgenologic Changes in Differential Diagnosis of Atelectasis. Willis F Manges and John T Farrell Jr. *Am Jour Roentgenol and Rad Ther*, October 1933, 30, 429-442.

Atelectasis is of two varieties, acquired and congenital, the latter type being relatively uncommon, some cases occurring in newborns and therefore being classi-

fied as congenital, may actually be acquired at birth by inhalation of foreign material. The acquired form occurs more often in adults than in children and is seen more often in males than in females. The causes are as follows: inhalation of a foreign body (usually organic matter, such as a navy bean), post-operative collapse, bronchial tumor, tuberculosis, pneumonia, asthma (all intrabronchial sources), enlarged tracheo-bronchial nodes, mediastinal tumor, aneurysm (extrabronchial sources). Characteristic roentgenologic findings are as follows: increased density of atelectatic area due to absence of air and vascular engorgement, elevation of diaphragm and retraction of mediastinal contents toward the affected side. If air can neither get in nor out, the action may be described as of a stop-valve nature, whereas if air can get in but not out the obstruction may be called 'check-valve,' the latter type producing at least temporarily an obstructive emphysema.

Unlike the atelectasis of bronchial tumor or long retained foreign body, massive post-operative collapse usually subsides spontaneously and without the sequelæ of drowned lung, chronic atelectasis, extensive bronchiectasis or abscess. The explanation is that in the post-operative type there is a disturbance of the bronchial secretory function to which the lung adjusts itself, whereas in the other types there is no regulation of the secretory mechanism, thus drowned lung and infective changes commonly follow unless the collapse is quickly relieved.

Atelectasis in tuberculosis is probably much more common than is diagnosed, but is apt to involve only small scattered areas of lung, such changes not being readily recognizable in the presence of pleuro-pulmonary infiltrations. In asthmatics, atelectasis may occasionally occur and be responsible for attacks of sudden dyspnea, the basis for the collapse probably being bronchial plugging with mucus.

Abscess of purely inflammatory origin is rarely associated with signs of atelectasis, whereas abscess secondary to bronchial or pulmonary tumors is often associated with x ray evidence of pulmonary collapse.

J E HABBE, M D

MUCOUS COLITIS

So-called Mucous Colitis. London Letter. *Jour Am Med Assn*, June 9, 1934, 102, 1951, 1952.

In a discussion at the Royal Society of Medicine, Dr A F Hurst showed the term was misleading and that specialism in therapeutics had dangers even greater than those in other branches of medicine. An expert in any line of treatment was tempted to accept the diagnosis already made in cases sent to him and to apply treatment without sufficiently full consideration. Fuller investigation might show that the so-called mucous colitis was the result of achlorhydria and could be rapidly cured by gastric lavage or administration of hydrochloric acid, or that it might be the first manifestation of carcinoma of the pelvic colon. He considered there was no such thing as mucous colitis.

Mucous colitis meant inflammation of the colon associated with the passage of excess of mucus. It was necessary to consider in what conditions an excess of mucus was passed. The secretion was increased in response to mechanical and chemical irritants. Hard feces in the pelvic colon and rectum acted as mechanical irritants. The most common chemical irritants of the colon are purgatives, they produced an excess of mucus, but again no inflammatory products. The use of irritating suppositories, enemas and douches always called forth an abundant secretion of mucus. Lastly when excess of undigested food reached the colon, as in achlorhydric gastritis and in enteritis, the colonic mucous membrane might respond by secreting mucous, although no colitis was present.

Cases of mucous colitis, in which liquid stools containing excess of mucous and of leukocytes, with sometimes a few red blood corpuscles, were known in which the sigmoidoscope revealed inflammation. In mucomembraneous colitis, the membrane was formed of coagulated mucus and did not contain inflammatory material. The condition should be called mucomembranous colic, it depended on abnormal irritability of the sympathetic nerve supply of the colon and was occasionally allergic, the mucous casts representing the Curschmann spirals of asthmatic patients.

He had found diathermy of the utmost value in the treatment of the frequent functional disorders of the intestine that result from abnormalities of the anal canal. Auto-intoxication resulting from stasis in the colon he regarded as a myth. Untreated constipation is rarely the cause of toxemia.

CHARLES G. SUTHERLAND, M.D.

THE PELVIS

The Differential Diagnosis of Phleboliths and Ureteral Calculi in Roentgenograms of the Small Pelvis. O. Buetzler. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 1934, 49, 253-262.

Sixty seven male and forty three female pelvises were reviewed for phleboliths—the former contained 254, the latter 196. They are not scattered throughout the pelvis as is often assumed but are concentrated in the lower pelvic segments distributed over a wider area in female pelvises, where many are located in the broad ligaments. Ureteral calculi are never located in an area of fingerbreadth width, following the linea terminalis. In male pelvises phleboliths are not encountered two fingerwidths below the sacro iliac articulations, in female pelvises they are found in such a location in only 1 per cent of all cases.

Excretion pyelography with stereo films is recommended for localization.

H. A. JARRE, M.D.

PEPTIC ULCER

The Diagnosis of Peptic Ulcer of the Esophagus. Gottfried Pesek. *Röntgenpraxis* February, 1934, 6, 99-102.

Roentgenologic demonstration of peptic ulcer of the esophagus has been reported only twice, as far as the author could find. In his case the roentgenologic diagnosis was confirmed at autopsy. In 1928 the patient had complained of difficulty and pain on swallowing. Roentgen examination and examination with the esophagoscope did not show any evidence of ulcer at that time, but, rather, the picture of a cardiospasm. The symptoms persisted and in 1933, at a re-examination, the roentgenologic diagnosis of an ulcer in a stenotic area of the esophagus just above the cardia was made. The niche and the stellate arrangement of the mucosal folds were typical. The patient died after a gastrotomy, and an autopsy confirmed the diagnosis of a stenosing ulcer in the cardiac portion of the esophagus.

The author believes that ulcers of the esophagus or scars following them are much more frequent than is now believed. He quotes the pathologist Gruber, who reports that the proportion of ulcer or scar in the cardiac portions of the esophagus and gastric ulcer is in the ratio of 1 to 30.

HANS W. HEFKE, M.D.

RADIUM

Radium Therapy of Hemangioma. W. Baensch. *Deutsche med. Wchnschr.*, 1934, 60, 923.

The author describes his technic in the treatment of large, cavernous hemangioma. He advocates the use of platinum radium needles, containing from 1 to 4 mg. radium element. Screened radium in the form of suitable surface applicators is then applied from the outside. Two to four applications are usually required, the total dose in large lesions is about 1,500 mg.-hrs. for children and 4,000 mg.-hrs. for adults. It is important to wait at least from four to six months after the treatment in order to obtain the optimal benefit. Several photographs are appended showing patients with extensive lesions before and after treatment.

ERNST A. POHLE, M.D., Ph.D.

SACRO-ILIAC JOINT

Typical Birth Trauma of the Sacro-iliac Joint. E. Philipp. *Röntgenpraxis* May, 1934, 6, 291-295.

While traumatic changes of the symphysis pubis are relatively well known, not so are similar changes in the sacro iliac joints. The author observed several women with pain in the sacro iliac region after childbirth, which radiated into the legs and was considered to be due to a sciatic neuritis. Gynecologic examination revealed a very tender swelling in the posterior pelvis in the region of the sacro-iliac joint. On roentgenograms of the pelvis the joint outline was hazy and irregular when compared with the normal side. There was no widening of the joint space.

One deals in such cases with a post partum traumatic hematoma which must be situated between the bone and the ligaments in front of the joint. Roentgeno-

logic re-examination some weeks afterward showed a normal appearance in all instances. Arthritic processes might have their beginning in these traumatic changes.

HANS W. HEFKE, M.D.

SCHÜLLER-CHRISTIAN SYNDROME

The Roentgen Therapy of Schüller-Christian's Disease. R. Stewart-Harrison. *Röntgenpraxis* May, 1934, 6: 305-307.

Favorable results of roentgen therapy have repeatedly been described in cases of Schüller-Christian's disease. In one of the author's cases the benefit of x-ray treatments was not very convincing. A 24-year-old man had all the signs of this disease: abnormal lipid metabolism, typical roentgen findings in skull and other bones, and a biopsy characteristic of it. The lungs were apparently also infiltrated by the same process. There was hardly any worthwhile effect of roentgen therapy, which was given in 3 doses, 300 roentgens each, to each focus of disease. It seems possible that some of the remissions reported after irradiation might have been spontaneous. A larger series of cases of this disease treated by roentgen rays is necessary to determine the value of this treatment.

HANS W. HEFKE, M.D.

SILICOSIS

A Comparison of the Development of the Specific Nodule of Silicosis and of Tuberculosis. W. S. Lemon and W. H. Feldman. *Archiv Int. Med.* March, 1934, 53: 367-377.

In order to obtain material for a comparative study of the respective morphologic reactions provoked in the lung by particulate silica and by bacilli of tuberculosis, intratracheal injections were given to two series of rabbits. The animals were killed at intervals of from four hours to four weeks after receiving the respective inoculums, and the course and character of the resultant cellular response were studied histologically.

When the organisms of tuberculosis are introduced intratracheally into some animals, and when particles of silica are similarly introduced into others, the reactions leading to production of the specific nodules in both groups are the result of certain factors which the injected substances have in common. Each substance is relatively inert and relatively impervious to injury or destruction by the tissues; each has the ability to become arrested within the lung and thereafter to stimulate hyperplasia of mononuclear cells. In each instance the lesion is found in regions rich in lymphatic tissue. The resulting specific lesion in each case is preceded by an exudative inflammation, more intense in the case of silica than in that of the organism of tuberculosis.

The ability of the living bacillus to grow and increase in number causes a provocative response which is progressive. The inability of silica to increase in

number of particles and the progressive removal of the initial dosage cause a gradual decrease in the number and size of the lesions.

Phagocytosis of bacilli of tuberculosis by polymorphonuclear cells is much more frequent than phagocytosis of particles of silica. The most actively phagocytic cell in either case is the alveolar phagocyte. Both irritants stimulate hyperplasia of mononuclear cells which ultimately assume an epithelioid appearance, and the nodules formed are constructed of cells of this type. No significant differences could be discovered between the epithelioid cell of the tubercle and the mononuclear phagocyte of the silicotic nodule.

The tuberculous nodule retained its cellular integrity longer than the silicotic nodule; it developed a necrotic center more slowly and much more slowly became invested by collagen. The reticulum of the tuberculous nodule was slower in development and was composed of finer interlacing fibers. The tendency to the development of caseous, massive pneumonia and to a spread by ulceration into adjoining bronchi or blood vessels was much more evident in tuberculosis than in silicosis.

Both types of nodules were avascular and similarly constructed; they had a similar distribution of fat droplets and a similar distribution of bacilli or particles within the nodules.

Both lesions appeared to be the reaction of the reticulo-endothelial system to irritative substances capable of initiating comparable inflammatory phenomena.

The results obtained appear to warrant the following conclusions:

1. The character of the cellular response to the irritative influences of particulate silica and to bacilli of tuberculosis is essentially the same; both promote the formation of characteristic tubercles.

2. The properties of the provocative agent responsible for the production of the silicotic tubercle preclude the formation of a structure characterized by continuous progression. This contrasts markedly with that formed as a consequence of the injection of bacilli of tuberculosis, which is usually of a progressive, destructive nature.

3. The similarity of the structural unit or tubercle invoked experimentally in response to particles of silica and to bacilli of tuberculosis is so striking as to make their certain differential identification impossible by ordinary morphologic criteria.

4. Although the pathologic characteristics of the two processes are practically identical during the early period of cellular progression, significant structural differences become evident as the duration of the diseases is extended.

H. A. JARRE, M.D.

THE STOMACH

Further Roentgen Ray Studies of Carcinoma of the Stomach. Maurice Feldman. *Ann. Jour. Roentgenol. and Rad. Ther.* October 1933, 30: 480-487.

The importance of careful consideration of indirect

signs in the detection of organic gastric disease either malignant or benign is stressed. Cases in the author's experience, showing definite clinical and laboratory evidence of organic gastric disease but no direct x-ray sign in the nature of a filling defect or niche, have called attention to the importance of the careful study of the indirect findings, of which disturbances in peristalsis reduction in size stereotyped shape and rapid emptying are particularly significant.

The earliest pathologic changes are principally in filtration or induration, with secondary inflammatory reaction. In such cases the roentgenoscopic findings are apt to be entirely normal but, by making a large series of roentgenograms and superimposing films or tracings of them, limited areas of infiltration fixation, or interference of peristalsis may be shown. Six additional cases are recorded illustrating such changes, all of which had serial roentgen studies over many months' duration and operative or clinical roentgenologic confirmation.

J E HABBE, M D

THE TRACHEA

Papillomatosis of the Trachea and Main Bronchi. A. Beutel. *Röntgenpraxis*, May, 1934, 6, 287-290.

A tracheogram and bronchogram of papillomatosis in the upper airways is described and reproduced. The papillomas produced filling defects of different size which were round or arranged in a bandlike fashion. They projected into the lumen and caused a wavelike boundary of the tracheal shadow. The appearance was that of fairly large esophageal varices. This is the first time to the author's knowledge that these changes have been demonstrated roentgenologically and correctly diagnosed.

HANS W. HEFKE, M D

TUBERCULOSIS, PULMONARY

The Importance of the Roentgen Examination in the Modern Treatment of Pulmonary Tuberculosis. B. H. Douglas. *Am Jour Roentgenol and Rad Ther*, September 1933, 30, 305-308.

By means of the x-ray one can diagnose pulmonary tuberculosis both quantitatively and qualitatively. By the term "quantitative" is meant, of course, a minimal, a moderately advanced, or a far advanced lesion. By "qualitatively" is meant an exudative, productive, ulcerative or combined type of reaction. Cavity formation very frequently defies diagnosis by physical examination without x-ray, and contrary to widespread opinion occurs relatively early in the development of many cases, thus constituting further reason for routine immediate x-ray study. In cases which show a positive sputum and x-ray evidence of cavity, when submitted to one or another of the several forms of collapse therapy, the disappearance of the evidence of cavity on the films and the disappearance of bacilli from the sputum constitutes very reassuring evidence that the therapy is proving effective. The author points out that prior to the introduction of x-ray in-

vestigation in chest diagnosis, pneumothorax treatment for pulmonary tuberculosis had been suggested and tried by certain workers, but given up because of inability to successfully estimate the results of this treatment, until close observation of cases by means of the x-ray was popularized, whereupon artificial pneumothorax took its deserved place in the armamentarium of the phthisiotherapist.

J E HABBE, M D

Roentgenological Manifestations of Allergic Processes in Pulmonary Tuberculosis. Max Pinner. *Am Jour Roentgenol and Rad Ther*, September, 1933, 30, 296-299.

According to the author, the exquisitely chronic course of pulmonary tuberculosis is composed of a series of acute phases, which may tend to be immediately regressive although ultimately progressive. Rapid clearing as shown by serial roentgen examination should not be considered evidence against the diagnosis of tuberculosis. The allergic reaction (modified reactivity of the body caused by previous infection) outcome is dependent upon dosage, virulence, time interval, and location. The roentgenologic appearances of allergic reactions are classified into three groups: (a) a focal area, usually 2 to 5 cm in diameter located in the periphery of one upper lobe of rather slight density and of blurred margins; (b) a more massive (at times lobar) infiltration resembling nonspecific lobar pneumonia; or (c) numerous widely scattered rounded, fluffy shadows, resembling metastatic tumors, or if smaller, pneumoconiosis. At times one sees exacerbations of old foci in the nature of hazy shadows surrounding old fibrotic or calcified areas; at other times one can identify bronchogenic metastases, and still again one may observe terminal bronchopneumonia, spreading into the lower lungs (these last appearances being tuberculous and not nonspecific lesions as so often diagnosed).

It is emphasized that without serial roentgenologic studies a vast number of such allergic manifestations will remain undiagnosed and even unsuspected. The prognosis at the onset of each such allergic reaction must be guarded, but on the other hand the possibility of benign outcome (by resorption or fibrosis) should not be underrated.

J E HABBE, M D

TUBERCULOSIS, RENAL

The Diagnosis of Renal Tuberculosis by Cultures Made from the Urinary Sediment. Daniel N. Eisendrath. *British Jour Urol*, March, 1934, 6, 37-45.

The author finds a close relation between the elimination of tubercle bacilli from a diseased (tuberculous) kidney and the anatomical changes incident to such an infection. For this reason one may find the bacilli at one examination and not at another. Under certain pathologic conditions there may be few living bacilli or none. When the number of bacilli is very small, one

logic re-examination some weeks afterward showed a normal appearance in all instances. Arthritic processes might have their beginning in these traumatic changes.

HANS W HEFKE, M D

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3 The similarity of the structural unit or tubercle invoked experimentally in response to particles of silica and to bacilli of tuberculosis is so striking as to make their certain differential identification impossible by ordinary morphologic criteria.

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H A JARRE, M D

THE STOMACH

Further Roentgen Ray Studies of Carcinoma of the Stomach. Maurice Feldman. *Am Jour Roentgenol and Rad Ther*, October 1933, 30, 490-487.

The importance of careful consideration of indirect

Telangiectasis and Radiation Therapy Leopold Freund and Josef G. Knoefach *Strahlentherapie*, 1934, 50, 326-332

A woman 58 years of age received x-ray therapy over the right breast following removal of a carcinoma. Three series were given consisting of 800 r each; the radiation filtered through 3 mm Al. Two months after the last treatment there appeared telangiectasis in the treated area, which looked very similar to that appearing as a late reaction after roentgen and radium treatment. Since the dose had been rather moderate and since no marked erythema had appeared, a biopsy was done in order to determine the nature of the process. Histological studies showed that the telangiectasis was in reality a recurrence of the carcinoma; it appeared in the form of the very rare "erysipelas carcinomatosum." Only 30 cases of this type have been published in the literature. The pathologic process spread and was so extensive that it could not be removed surgically. Intensive radiation therapy brought about relief and at least temporary standstill of the process.

ERNST A. POHLE, M.D., Ph.D.

The Biologic Treatment of Carcinoma and its Relation to Radiation Therapy of Neoplasm Dr. Fichera *Strahlentherapie*, 1934, 50, 302-311

The author reviews briefly his investigations dealing with the organotherapy of malignant tumors. Based on 25 years of research, he recommends the treatment of inoperable far advanced, malignant disease with extracts of embryonic tissues, particularly spleen and thymus. In 9 per cent out of 100 patients who were inoperable and radioresistant, the tumors regressed entirely when treated with these extracts, while in 8 per cent there was no further growth or extension. In earlier cases a combination of radiation therapy and organotherapy should prove of value. A few illustrative case histories are appended.

ERNST A. POHLE, M.D., Ph.D.

What Are the Accomplishments of Radiation Therapy in Inoperable Carcinoma of the Cervix? F. G. Dietel *Strahlentherapie*, 1934, 50, 297-301

The author compiled 40 groups of statistics from the world literature. His analysis showed that during the period from 1912 to 1928 a total of 7,814 women with inoperable carcinoma of the cervix were treated by irradiation, of whom 882 (or 11.3 per cent) were cured. Thirty of the statistical groups showed that with radium alone the percentage of cure was 9.9 per cent, with x-rays alone 10.5 per cent and with combined roentgen radium treatment 13.4 per cent. There seems to be no doubt that the combined therapy shows a marked improvement in the end results.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Mediastinal and Lung Tumors René du Mesnil de Rochemont *Strahlentherapie*, 1934, 50, 290-296

The author groups tumors of the mediastinum and lungs under three headings. The first group does not lend itself at all to radiation therapy; he mentions lipoma, fibroma, chondroma, teratoma, cysts and changes in the heart, pericardium, and aorta. The second group comprises carcinoma of the bronchus and metastases from other primary foci. Some of these cases may be influenced by irradiation. The third group, tumors of the mediastinum, consists chiefly of involvements in lymph glands, leukemia, Hodgkin's disease as well as lymphosarcoma, which are, as a rule, radiosensitive. In the radiation treatment of mediastinal and lung tumors it is important to avoid systemic reactions as far as possible. The fractional application of the dose is therefore the method of choice. It is often necessary to limit the treatment to one field per day. A surface dose of from 200 to 400 r, given over an area of 10×15 sq cm, is recommended. A total of 18×200 r per field can be administered provided that an irradiation of 1 mm H.V.L. in Cu is used. The author usually gives 7 to 8 r per minute, so that a single exposure does not exceed from 30 to 50 minutes. The dose effective at the site of the disease may vary from 2,000 to 3,600 r. If patients do not tolerate high doses, it is necessary to reduce the dose per field to 100 r. Most of the 20 cases of lung tumors which the author treated in the past year were so far advanced that one half of them died within three months after beginning treatment. The remaining half lived about a year, four cases lived two years—among the latter was a carcinoma of the bronchus demonstrated at the autopsy. It is remarkable, however, how much the subjective symptoms can be improved by proper irradiation. In cases with lymphosarcoma of the mediastinum it is necessary to start with moderate doses in order to prevent general intoxication. One of the patients belonging to this group is living nine years after the treatment.

ERNST A. POHLE, M.D., Ph.D.

The So-called Specific Effects of Short Electric Waves in the Treatment of Malignant Disease M. Haas and Dr. Lob *Strahlentherapie*, 1934, 50, 345-347

The author studied the effect of short electric waves (2.8-20 meters) on animal tumors in all stages, namely, beginning with recently implanted neoplasms up to tumors the size of a hen's egg. They could not find any changes in the tumors due to the effect of the electric waves.

ERNST A. POHLE, M.D., Ph.D.

Superior Pulmonary Sulcus Tumor Further Observations, with Report of Two Additional Cases Harold W. Jacob *Jour. Am. Med. Assn.*, July 14, 1934, 103, 84-87

Evidence is presented supporting the view that superior pulmonary sulcus tumor is an atypical form of primary bronchogenic carcinoma. Opportunity to examine autopsy material from a case of this sort,

is more apt to find them by culture methods or by animal inoculation than by staining methods

In from 15 to 20 per cent of the cases the author was unable to find tubercle bacilli in spite of prolonged search of stained specimens of urinary sediments from patients in whom he suspected or had already made a diagnosis of renal tuberculosis

In the first series of 57 cases the cultures were positive in 30 cases, whereas the stain was positive in only 20 of the 30 cases. In the second series of 13 cases, the culture was positive in seven, whereas the stain was negative in the five specimens received but had been positive at previous examinations in four of the five cases

The bladder specimen may be negative, and that taken directly from the kidney be positive, hence it is always advisable to examine the urine obtained by ureteral catheterization

The inoculation of the guinea pig has many drawbacks. It is the opinion of the author that the culture should always be controlled by animal inoculation to avoid error. The cultures should be kept under observation for at least 90 days. The author found in three of his cases that the cultures were only found positive on the sixtieth and ninetieth days, respectively

The application of the culture method has been so greatly simplified since 1924 that it should be employed as a routine measure whenever the stain is negative. The culture method is cheaper, more rapid, and more apt to yield positive results than animal inoculation. Compared with staining methods, the culture method is, of course slower, but will in the future be of inestimable value in the 15 to 20 per cent of cases in which one or more stains are negative and yet one suspects the presence of a renal tuberculosis

DAVIS H. PARDOLL, M.D.

TUMORS (DIAGNOSIS)

Roentgenologically Circumscribed Tumors of the Alimentary Canal and the Difficulties of Their Differential Diagnostic Interpretation. K. Frick and P. Ott. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 1934, 49, 441-456

Reviewing their 1,300 examinations of the alimentary canal during 1933 the authors found a number of circumscribed tumors mostly in the stomach, some in the duodenal bulb and the colon sigmoid. Neither from the clinical examinations nor from the correlation of these with roentgenologic findings was it possible to determine the character of these tumors with certainty and the diagnosis had to be left to the pathologist. These tumors represented partly carcinomas, partly myomas, granulomas, pedunculated polyps, chronic inflammatory tumors. Of these, the pedunculated polyp is most amenable to diagnosis. The beautiful detail of mucosal structure demonstrated in the illustrations is well worth seeing. The diagnostic limitations of clinical medicine and roentgenology are shown and the localizing value of correct roentgenologic procedures is emphasized

H. A. JARRE, M.D.

TUMORS (THERAPY)

Malignant Tumors and Their Treatment by Irradiation. A. Hedfeld. *Strahlentherapie*, 1934, 50, 312-325

The author gives a brief analysis of the present status of the cancer problem. He states that neoplastic diseases are not only local but systemic. It seems, therefore, that the treatment of the local manifestation alone will not lead to a permanent cure. Diet and organotherapy are important parts in the treatment. The author also does not believe in the radical operations as practised now and quotes as an example of a less radical procedure carcinoma of the breast. He has used the following method during the last four years. Operable cases are treated first by roentgen rays. If the tumor is reduced in size, the residual growth is removed with the endotherm knife under local anesthesia. Attention is paid to the diet which should be rich. If glands are involved, the tumor of the breast proper is not removed until the glands have completely disappeared. During the last three months he has also been using the organotherapy as developed by Fichera.

ERNST A. POMLE, M.D., Ph.D.

Report Regarding the Experience in Zürich with Protracted Fractional Roentgen Therapy from 1929 to 1932 in Tumors of the Upper Air Passages and Digestive Tract. H. R. Schinz and A. Zuppinger. *Strahlentherapie*, 1934, 50, 237-277

From April, 1929 to 1932 184 cases with malignant tumors of the upper air passages and digestive tract were seen in the Roentgen Institute of the University of Zürich. Only 23 of these patients were operable but 6 already showed metastases. 135 cases completed the entire course of treatment. After two years 25.9 per cent were alive and free from symptoms. 22 per cent of the 135 patients are alive for a period of from two to five years. Calculated for the three year cure period 18 per cent represented the absolute cure and 23.8 per cent the relative cure.

In tumors of the inner nose and sinuses it is necessary as a rule to use combined surgery and radiation treatment. Tumors of the mouth are usually more resistant than tumors of the pharynx. Sarcoma of the mesopharynx seems to respond well. For that reason the authors used the protracted fractional dose method as the method of choice in this neoplasm. In carcinoma of the tonsil the tumor mass usually shrinks following roentgen therapy. It is often necessary to treat the residual tumor by radium or electrocoagulation. The prognosis for tumors located at the angle between palate and tongue is usually poor. For tumors of the hypopharynx the protracted fractional dose method is to be considered as the method of choice. Tumors in the inner larynx are also usually radiosensitive. No late injuries were seen during the period on which the report is based. Some acute reactions were observed which were due to over dosage. The authors state that individualization of radiation therapy is essential.

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CHRONIC NON-TUBERCULOUS INFLAMMATION OF THE LUNG¹

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|| N working with lung diseases, the conviction has been growing on me that we do not need improvement in x-ray technic so much as we need a more intimate knowledge of tissue changes and the ability to interpret the shadows we now obtain in terms of a thoroughly familiar histopathology. In the roentgenology of chest lesions, we have centered our attention too much on securing films in faster time and with finer detail, and have devoted entirely too little study to the pathologic genesis of the several disease processes. It would be embarrassing to many of us if asked to give a detailed description of the microscopic changes in an acute inflammation of the lung parenchyma, or the tissue alterations which occur when such an acute inflammation changes to chronic inflammation. Yet that knowledge is more essential to the accurate interpretation of lung shadows on the roentgenogram than is the securing of extra fine detail or contrast. Until we are thoroughly familiar with the differences in cellular response following the entrance of silica dust, tubercle bacilli, or monilia into the lung tissues, no refinement of technic in the production of films will improve our ability to differentiate the shadows of silicosis, tuberculosis, and fungus infection in the lungs. Furthermore, we will not acquire this essential patho-

logic knowledge by reading text-books or from the all too infrequent fine descriptions in medical articles, unless this is supplemented by personal study of gross pathologic specimens and stained sections. We must be able to visualize clearly the histogenesis of inflammatory processes in the lungs, if we hope to advance beyond stereotyped mediocrity in the interpretation of x-ray densities. Rather than a five-thousand-dollar equipment to make chest films in a hundredth of a second, the best investment that any x-ray laboratory not already so equipped could make would be a two-hundred-dollar microscope plus the ability and willingness on the part of the roentgenologist to use it constantly.

We have a few excellent examples of pathologic knowledge personally acquired and efficiently applied by roentgenologists to their problems. To mention three will be sufficient for illustration. Dunham's work on pulmonary tuberculosis, which was itself based on Miller's monumental researches into the microscopic anatomy of the lung, Pancoast and Pendergrass's work on pneumoconiosis, and, outside the lung-field, Cole's work on gastric ulcer. Quoting William Snow Miller, "For the correct interpretation of roentgenograms [of lungs] definite knowledge of the distribution of the bronchi, the arteries, the veins, the lymphoid tissue, the lymph follicles and the lymph nodes within

¹ Read before the First American Congress of Radiology at Chicago Sept. 25 to 30, 1933.

characterized by pain, Horner's syndrome, destruction of bone and atrophy of the hand muscles, convinced the author that the tumor arose from the mucosa of the terminal bronchioles in the apex of the lung. A modification of Coutard's method of intensive deep roentgen therapy failed to control the symptoms of this disease in a second case. Chordotomy should be considered as a valuable palliative procedure.

CHARLES G. SUTHERLAND, M.D.

Roentgen Therapy of Scleroma of the Upper Air Passages. R. K. Kruglikowa. *Strahlentherapie*, 1934, 50, 333-344.

The author analyzes 172 cases of scleroma which were observed in the Roentgen Institute in Kiev. He recommends 160 K.V. 0.5 mm Cu + 1 mm Al, $\frac{1}{4}$ to $\frac{1}{2}$ H.E.D. at intervals of from three to four weeks and later two months. His experience shows that roentgentherapy is apparently the method of choice. Scleroma of the nose is first treated by CO₂ snow and then followed by irradiation. Certain preparations of stibium seem to act as a sensitizing medium and are being used, therefore, in conjunction with roentgen therapy. Tabulations show the distribution of the lesions as to anatomical locations and

the results obtained. A series of illustrations showing patients before and after treatment is also appended.

ERNST A. POHLE, M.D., Ph.D.

ULTRA-VIOLET LIGHT

The Effect of Ultra violet Rays on the Carbohydrate Metabolism. Paul Kallos and Liselotte Kalle-Deffner. *Strahlentherapie*, 1934, 50, 191, 192.

Rothmann stated that exposure to Finsen light decreases the blood sugar of normal persons as well as those with diabetes. The authors studied this therapeutic possibility on four rabbits. They found that if the animals were kept in a dark room there was no change in the blood sugar and sugar tolerance. Exposure to the quartz mercury vapor lamp led to a definite reduction in the blood sugar manifesting itself one hour after the exposure and lasting from six to eight hours provided that no food was given. If a definite skin erythema occurs after the irradiation, the blood sugar drops and at the same time the sugar tolerance is definitely increased. This is still present eight to ten days after the exposure. Based on these experiments the authors have started administering this treatment to diabetic patients.

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tions that occur in the primitive organism take place here. The purpose of the complex arrangement of blood vessels under the control of nerves and internal secretions is to transport the blood cells and fluids to and from the point of injury, both cells and fluids leave the capillaries and invade the mesodermal connective tissue reticulum, where their essential functions are performed. When white blood cells are present in excess, or when their work is completed, they return by way of the lymphatic channels to the blood stream. This was beautifully demonstrated by the work of Menken and Freund, who showed that the efferent lymphatic channels surrounding any zone of inflammation are packed full of polymorphonuclear white cells returning to the blood stream.

There are four degrees of acute inflammation, all pertinent to an understanding of lung lesions.

(a) In the simplest type, such as a cut without bacterial invasion, the above outlined process occurs with leukocytes and serum migrating into the intercapillary connective tissue, fibrin is liberated, sealing the edges of the cut, fibroblasts proliferate and interlace across the cut while new epithelial cells cover the defect on the surface, the slight debris of dead cells is phagocytosed and removed, the fibrin is absorbed, and the injury is healed.

(b) If there has been loss of tissue (local necrosis), with or without bacterial invasion, the reaction is simply greater in degree, more leukocytes migrate to the spot and more fluid is exuded, the dead tissue is either removed by phagocytosis or is dissolved and carried away by the lymphatics, after three or four days, a zone of less debris appears at the edge of the tissue destruction where it adjoins the living cells, this bordering zone is composed of newly formed capillaries, held together by a very fine connective tissue reticulum, and is the granulation tissue which does not arise from migrating leukocytes, but must grow from the surrounding healthy tissue, the cells of this con-

nective tissue reticulum (fibroblasts) finally change into white connective tissue or cicatrix.

(c) Suppurative inflammation is the third stage of the same process. When leukocytes are attracted to a point of injury in great numbers and many of them die, the phagocytosis and dissolution of cells cannot keep pace, and we will find an opaque fluid at the point of inflammation, consisting of dead and dying leukocytes and debris suspended in exuded plasma, this opaque fluid is the familiar pus. Usually this degree of inflammation is due to bacterial invasion and growth and occurs in an orderly manner. Organisms first grow at the point of invasion and destroy tissue cells for a time before adaptive reactions develop, when bacterial toxins are sufficiently diffused to arouse the reaction of chemotaxis, leukocytes are drawn out of the surrounding capillaries in large numbers, completely crowding out the tissue cells. Many leukocytes are destroyed, new ones pouring in, and the efferent lymph channels become engorged with phagocytic debris. Should the adaptive resistance of the leukocytes and tissue cells succeed in halting the spread of the bacterial invasion, a localized abscess or ulceration will result, with pus formation. When repair of this abscess or ulceration occurs, the bacteria become fewer and fewer, the undestroyed leukocytes and debris are carried away into the lymph channels, and granulation tissue repair proceeds.

(d) The fourth degree of acute inflammation is represented by progressive extension of the inflammation without successful arrest or abscess formation.

Chronic inflammation represents the persistence of an injury which cannot be entirely eliminated, the adaptive changes merging gradually into a continual sequence in which the connective tissue cells take the dominant part. The polymorphonuclear phagocytes of acute inflammation first disappear, being replaced by mononuclear cells, such as the large and small lymphocytes and the plasmatocytes of

the normal lung is absolutely necessary, for it is impossible correctly to understand the pathological without a previous knowledge of the normal." Assuming all that roentgenologists doing work with lung diseases are thoroughly familiar with lung anatomy as taught by Miller, it is just as essential to know from observation under the microscope what is happening in the alveoli, the capillaries, the lymphatics, the lymph follicles, and the lung reticulum, in the various types of lung inflammation, if we expect to summarize these intelligently in a visible lung shadow and interpret the sum total from the x-ray film as a probable definite kind of lung lesion.

For these reasons, this paper will attempt no categorical presentation of non-tuberculous inflammation, but a brief and general discussion of the changes produced in the lungs by chronic inflammation, suggesting things we have yet to learn, rather than reviewing the few things we actually know about such lesions.

Adam's definition of inflammation seems to be the most pertinent to x-ray findings of any which we have. "The local or adaptive changes resulting from actual or referred injury." Not a word is wasted in this definition and every word is meaningful. Inflammation is a tissue change and it is the local change, as distinguished from infection, which embraces also the systemic reaction. Such local changes are adaptive, representing the attempt on the part of the cells and tissues to adjust themselves so as to resist the injury and render it innocuous. Inflammation follows injury, whether traumatic, physical (heat, cold, electric, or metabolic), or microbic invasion. Such an injury may be at the spot or may be referred from a distance. There are two grades of inflammation—acute and chronic—which merge imperceptibly into each other, and since chronic inflammation is but the continuation of the adaptation to acute injury, we cannot understand chronic inflammation without a knowledge of the acute stage.

The adaptive reaction to local injury,

which is the basic change in all inflammation, is better understood if we will recall what happens in a very simple organism. In the larva of the simple metazoan *Astropecten*, there is a single layer of ectodermic cells invaginated at one end into a very primitive endoderm. Within the primitive mesodermic cavity are wandering cells which thus early in the evolutionary process have developed phagocytic powers. If a small foreign body gains entrance to this cavity, these wandering cells attempt to deal with it. If the foreign body is small it may be ingested by one of the phagocytes and destroyed, if it is too large for this, the cells surround it, fuse into a multinucleated mass, and fix the foreign body in one position—a very primitive granulation or cicatricial tissue.

In the more complex organisms, the mesodermal tissue still performs this adaptive and protective function, through the activity of white blood cells, connective tissue cells (reticulum), and certain constituents of the circulating fluids. The difference between that which takes place in the primitive organism and in the human lung is one of degree only and due to the greater complexity of the tissue structure of the lung. The basic biologic reaction is the same in both instances.

If the inflammatory reaction in one of the tissues used in physiological laboratories for this purpose is observed, the same reaction can be seen, modified only by the presence of blood vessels and a more complex organization. When a local injury is inflicted on such a tissue, the series of changes taking place in the arterioles and capillaries is designed to bring to the spot of injury the same mesodermal cells, and to create conditions which will best permit the tissues injured to adapt themselves to the harmful agent. Following the primary arteriolar contraction, the capillaries dilate and the blood stream slows, the blood cells are rearranged with leukocytes peripheral and erythrocytes central, the leukocytes then migrate and fluids exude into the intercapillary reticulum, after which the same cellular reac-

solution has much the same effect as a bacterial toxin. The first phagocytes to appear are polymorphonuclear, the clasmatoocytes appear later, are extremely active, break up less readily, and may become transformed into fibroblasts. The poison resulting from the disintegration of silica is a fibroblastic stimulant, leading to a progressive fibrosis which continues as long as the irritant remains. The changes found in pneumoconiosis, especially of the silicotic variety, are due to progressive fibrosis in the lung reticulum rather than to mechanical injury of the dust itself. The mottling which is so familiar is caused by fibrotic nodules which have formed about invisible dust accumulations in lymph follicles. In the anthracotic form of pneumoconiosis, the dust particles are not soluble and therefore not toxic, the densities observed being due to mechanical accumulations of coal dust.

The histogenesis of the tubercle, as described by Dunham, is quite similar. When tubercle bacilli are inhaled, they are removed from the alveoli by the same type of mononuclear phagocyte and are lodged in the lymphoid follicles, where they are surrounded and finally encased in a fibrotic nodule. The tuberculous process, like silicosis, spreads along the lymphatics. The chemical poison of dissolved silica is quite diffusible and produces a generalized peribronchial fibrosis accentuating the fine linear markings of the peribronchial tree before the familiar nodular fibrotic lesions appear. Tuberculosis differs from silicosis in a more localized lesion and in the greater accumulation of tissue fluids from allergic dilatation of blood vessels and exudation of plasma into the interalveolar tissues, producing the familiar hazy cloud studded here and there by the denser shadows of single or conglomerate tubercles.

If we will look at one of Miller's illustrations showing the respiratory bronchus and vein and will imagine tubercles developing wherever lymphoid follicles appear, and the whole area suffused with edematous fluid from lymph stasis, we will have

something like the condition exhibited by a typical tuberculosis. Ordinarily what we see is the fan-shaped area of an edematous secondary lobule, studded here and there by the denser primary lobules. Silicotic densities are quite similar, as we would expect them to be, when we consider that the cellular response in the two diseases are almost identical, silicosis lacking only the allergic diffuse cloudiness. The film of a silicotic lung, in any localized area, shows little to distinguish it from tuberculosis. The history, the appearance of the lung as a whole, the sizes of nodules, and the accompanying findings must make the differentiation.

The simplest and perhaps the commonest type of non-tuberculous inflammation is that which is secondary to upper respiratory infection. The localization in the lung may take place by inhalation or through blood stream metastasis. The density of such a lesion is usually regarded as due to atelectasis in a secondary lobule, or to uniform filling of the alveolar structure with inflammatory exudate, producing a localized homogeneous density. The inflammatory process may take one of three courses, according to the three degrees of inflammation previously mentioned.

(1) The lesion may resolve and entirely disappear.

(2) It may pass into the stage of chronic inflammation, with fibrous tissue replacing normal lung tissue and producing more or less permanent densities of the cicatricial type, this may result in deformities of the bronchi and bronchiectasis. The active parenchymal inflammation may disappear, leaving the deformed bronchi which can be recognized only when outlined by opaque oil. The fibrotic changes in the lungs may be very extensive and the inflammation may continue as a progressive chronic disease, in which the bronchiectatic element may or may not be important.

(3) The parenchymal lesion may suppurate and form abscess, this may evacuate and heal or may remain as a permanent

the reticulo-endothelial system. The reticular connective tissue next increases in amount, its fibroblasts multiplying and finally developing white connective tissue. These changes may continue indefinitely, if bacteria continue to grow in the tissues or other fibroblastic stimuli persist.

When we attempt to apply these very elementary facts about inflammation in general to lung inflammation in particular, we at once realize the necessity for correlating them with histologic anatomy. Fortunately for those who wish to pursue this quest, the work of Miller has made this part of the journey easy, and his classic descriptions are available to every one. We can here only recall the importance of the unit of lung structure—the lobule—and the relations between alveoli, pulmonary artery, and pulmonary vein, with the location of lymphoid follicles, and especially the reticulum of the lung which fills all the space between these structures and is the essential tissue in the changes produced by chronic inflammation in the lung parenchyma.

Further review of the changes in acute inflammation in the lung cannot be made, except to recall that the air-containing alveoli modify the usual inflammatory reaction by offering a path of less resistance into which the cells and fluids pour. When acute inflammation becomes chronic, the air cells open up by absorption of this exudate, and the essential changes continue in the lung reticulum.

Atkinson states that chronic lung inflammation or fibrosis may arise from any one of six causes. Even if this grouping should not include all cases, it will be sufficient for our consideration.

- (1) Following acute respiratory infections
- (2) Tuberculosis
- (3) Syphilis
- (4) Pneumoconiosis
- (5) Irritant gases
- (6) Fungus infections

The work of Dunham and Miller on tuberculosis and of Pancoast and his as-

sociates on pneumoconiosis furnish an excellent foundation on which to build the study of chronic lung inflammation. In beginning the study of the histogenesis of chronic lung inflammation one can do no better than start with the known facts about the cellular reactions following the inhalation of silica dust into the lung alveoli. In addition to the reports by Pancoast and Pendergrass, other excellent articles are those by Boislumiere (1933), Friedlander (1928), Meriwether and Sayers (1931), Britton and Head (1931), Lynch and Smith on asbestosis (1930), Russell (1930), Gardner (1929), Chapman (1932), Lemon and Higgins (1932), Ohman (1928), and others.

In the experimental observations of Lemon and Higgins a suspension of barium sulfate colored with India ink was inhaled by anesthetized dogs, and within forty minutes these particles had been carried to the lung periphery. The defense mechanism consisted (1) in removal of particles from the lung alveoli by phagocytes of endothelial origin (clasmatocytes), (2) transportation of the dust by lymphatic drainage, (3) encapsulation of the particles by fibrosis. Attention is called to the fact that this is exactly what occurs in the primitive metazoon larva, and it will be found that this process, modified only by tissue complexity, is what takes place in any lung inflammation. The endothelial cells, or clasmatocytes, are now recognized as being of mesenchymal origin, the same as the lining cells of the alveoli. When foreign particles or bacteria invade the alveoli, these lining cells shed and become actively phagocytic, being replaced by more embryonic cells of the interalveolar septum. These phagocytes pass freely back through the alveolar wall and into the lymphatics.

When silica dust enters the alveolus, the resulting reaction closely resembles chronic bacterial inflammation. The dust is first removed as a foreign body by phagocytes and carried to lymph follicles. There the silica particles are partly dissolved by the alkaline tissue fluids and the resulting

solution has much the same effect as a bacterial toxin. The first phagocytes to appear are polymorphonuclear, the clasmatoctes appear later, are extremely active, break up less readily, and may become transformed into fibroblasts. The poison resulting from the disintegration of silica is a fibroblastic stimulant, leading to a progressive fibrosis which continues as long as the irritant remains. The changes found in pneumoconiosis, especially of the silicotic variety, are due to progressive fibrosis in the lung reticulum rather than to mechanical injury of the dust itself. The mottling which is so familiar is caused by fibrotic nodules which have formed about invisible dust accumulations in lymph follicles. In the anthracotic form of pneumoconiosis, the dust particles are not soluble and therefore not toxic, the densities observed being due to mechanical accumulations of coal dust.

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cavity Sweany and his associates have described a chronic bronchopneumonia with progressive abscess formation, caused by the Friedlander bacillus, which is difficult to distinguish from fibro-cavernous tuberculosis on the x-ray film. It was once thought that when cavitation was found associated with silicosis, a complicating tuberculosis could safely be presumed. With the demonstration that Friedlander's bacillus can produce chronic progressive cavitation in the lungs, usually starting at the apex and developing downward, this point needs further study. Lung lesions from upper respiratory infection have been written about by Stewart and Platou (1929), Dunham and Skavlem (1922, 1927, 1928), Kistner (1927), Preston (1927), Atkinson (1925), Manges (1930), and others.

In lung syphilis we lack a close correlation between the histologic pathology and the x-ray findings. Carrera, in 1925, furnished us with a very excellent pathologic research into the tissue changes of lung syphilis, but these were not correlated with roentgenographic densities. In general, we know that the method of invasion of lung tissue by syphilitic infection must necessarily differ from the method of invasion by tuberculosis or silicosis. Dust and tubercle bacilli are inhaled into the lung alveoli, are taken up by phagocytes, and pass through the lymphatic system. Syphilis is blood-borne and its lesions are perivascular. Although the histologic appearances of tuberculosis and syphilis are quite similar, there is enough difference in the method of

spread, taken in conjunction with the peculiarities of lung architecture, to make us anticipate a different type of density. Grossly, tuberculosis is carried by the lymphatics to the lung periphery and gradually works back toward the hilus, producing a fan-shaped shadow with base outward. Syphilis infiltrates along the blood vessels, tending to show its heaviest shadow at the lung hilum with radiations into the lung-field, if its shadows are at all pyramidal the apex is more likely to be outward. Resolution under treatment tends to confirm the diagnosis, just as it would any other lesion suspected of being syphilitic.

Mycotic infections of the lung is a large and increasingly important subject. We have seen actinomycosis, blastomycosis, coccidiosis, moniliasis, and spirochetosis all mistakenly diagnosed as tuberculosis and sent to the Southwest for climatic treatment, when they might just as well have been treated at home by iodides and radiation. In one small tuberculosis sanatorium in Arizona, during the past seven years, the enterprising medical staff members have isolated eleven cases of bronchomoniliasis, most of whom were sent there with a diagnosis of tuberculosis.

In closing, it is necessary only to repeat that there is much for us to learn about lung inflammation and our house of knowledge cannot be constructed from the roof down, but must be built from the ground up, and on the solid rock of gross and microscopic pathology, if it is expected to withstand the storms of criticism or the changing tides of time.

DILATATION OF THE LEFT AURICLE TO THE RIGHT¹

By JOHN C RUDDOCK, M D , F A C P , Los Angeles

DILATATION of the left auricle to the right was first described and reported by Owen and Fenton, in 1901. They described and reported the clinical and anatomic features of this condition, as demonstrated in a woman patient aged 40 years, and laid stress upon the finding of a systolic pulsation and thrill in the right axilla, with dullness at the right base suggesting pleural effusion

examined by x-ray methods, found in 5 per cent of the cases examined, extension of the left auricle to the right, beyond the right auricle.

It has long been recognized that, in the presence of definite obstruction to the free flow of blood through the mitral orifice, the first of the cardiac chambers to be affected by the altered relations of intracardiac pressure is the left auricle, its in-

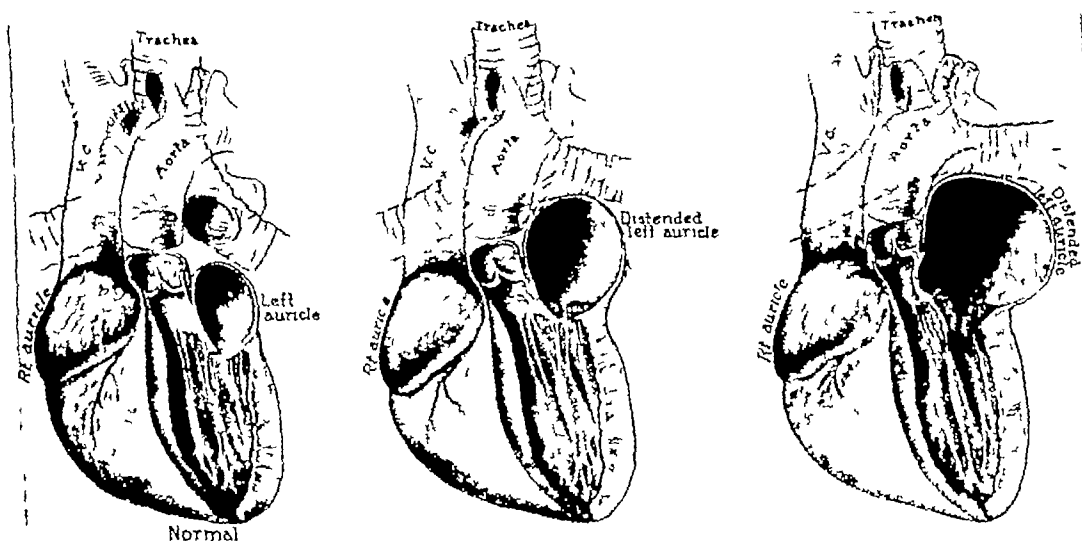


Fig 1 Schematic drawing, showing the dilatation of left auricle with the closure of the mitral orifice.

Since their description, similar cases have been reported from time to time. Even in its earliest stages, before obvious physical signs begin to appear, projection of the left auricle to the right is demonstrable with a relative degree of certainty by x-ray examination.

This condition has received wider recognition in France and Germany than in England or America, because of greater perfection of technic in radioscopic methods of examination of the heart. Bordet, in a large series of cases of mitral stenosis

crease in size largely being the result of dilatation (Fig 1).

This dilatation, with its accompanying volume increase, causes more work by the right side of the heart, which, if the process has had an insidious onset, results in an enlargement due to hypertrophy of the right ventricle. The individual heart, however, remains compensated unless there is a failure of the right ventricle or the tricuspid valve.

With the advent of exacting methods of heart measurement by means of x-rays, it is evident that the relations of the various heart chambers must be definitely known so that the appearance of the heart

¹ Read before the General Medicine Section of the California Medical Association at the Sixtieth Annual Session, San Francisco April 27-30, 1931.

shadow on the x-ray film may be correctly interpreted (Fig 2)

It is also evident that the relationship of

the right, at the point of attachment of the vena cavæ with the right auricle

In a case of compensated mitral ste-

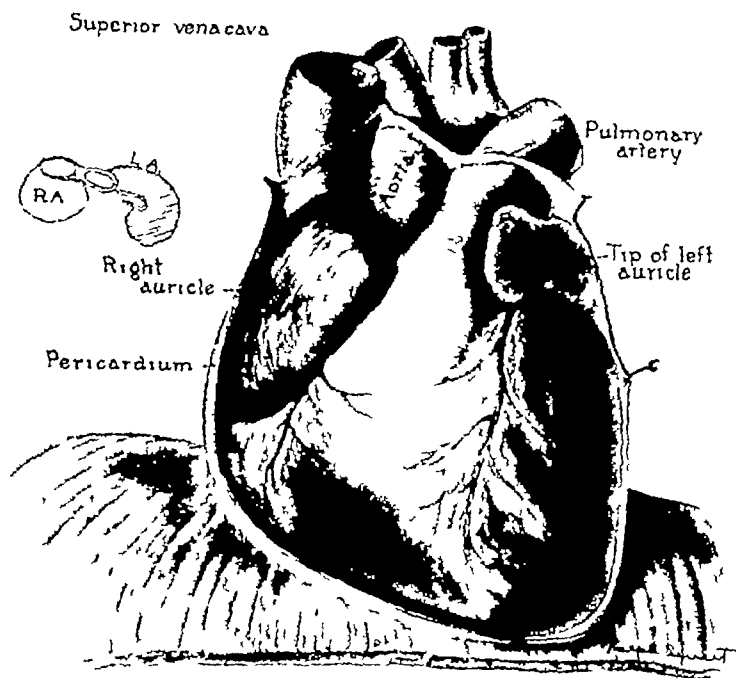


Fig 2 Drawing showing anterior view of normal heart with diagram of relation of right and left auricles

the heart chambers is materially changed in compensated and decompensated cases, and also that the relationship of the various other chambers are materially changed because of individual hypertrophy or dilatation due to failure of specific valves

In describing the upper chambers of the heart, we have named and spoken of the right and left auricles, but it would be more exact to rename them as the anterior right auricle and the posterior left auricle, because in the latter, almost the entire auricle lies posteriorly

It is a well known fact that dilatations of the left auricle cause an encroachment on the retro-cardiac mediastinal space, and even moderate enlargement may cause a pressure on nerves, blood vessels, bronchi, and esophagus. The junction of the left border of the right auricle with the right border of the left auricle is on the posterior aspect of the heart, and, to

nosis in which only the left auricle is extremely dilated, this junction is pushed anterior and to the right, and at the same time the dilated left auricle obliterates the retro-cardiac space. This pushes forward the right auricle, so that in extreme cases it lies almost entirely anterior (Fig 3)

The roentgenogram in the anteroposterior view will then show the projecting left auricle forming either a part, or the whole, of the right border of the cardiac shadow, and producing a sharply convex bulge to the right (Fig 4)

The convex bulge is present because the lower portion of the junction of the right and left auricles is held stationary by the inferior vena cava as it comes through the diaphragm, and the bulging must take place above by pushing the superior vena cava forward and to one side. The maximum projection to the right is usually then some inches above the diaphragm

level, and the cardiohepatic angle is thus acute. In extreme degrees of enlargement, the left auricle may form the whole

lated right auricle, we then have the same relationship that is present in the normal heart. The right border of the cardiac

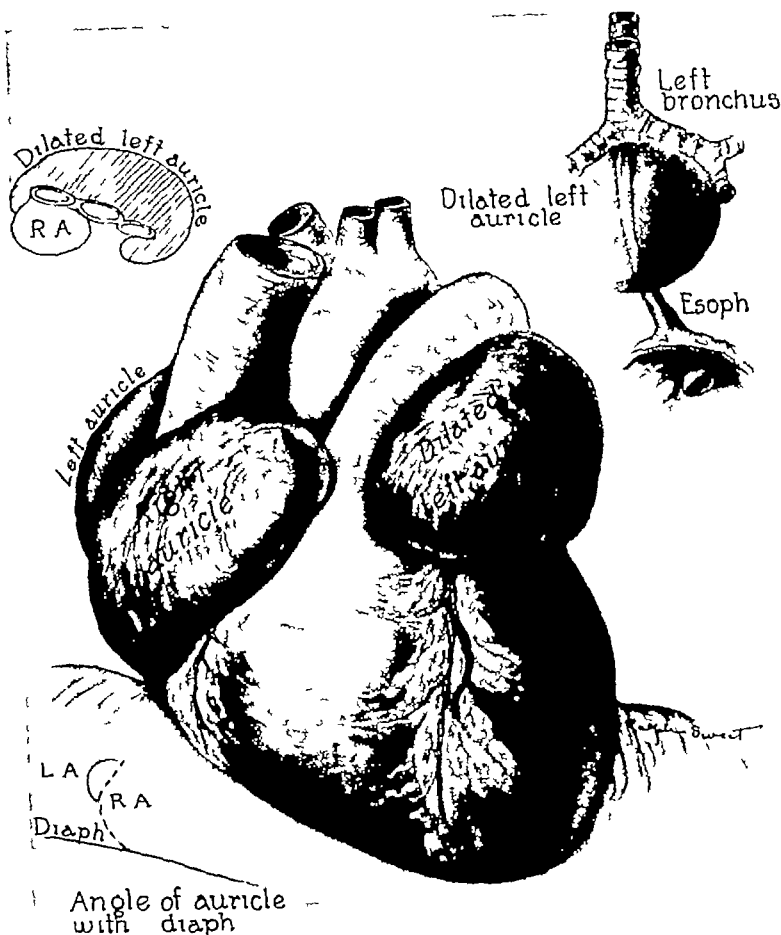


Fig 3 Drawing showing dilated left auricle, as seen from anterior aspect of heart. The relation of the right and left auricles may also be seen

right border of the heart outline. In enlargement of lesser degree, the left auricle projects to the right above the right auricle, which forms the lower part of the right border of the cardiac shadow. This is true only in cases of mitral stenosis without signs of decompensation. This observation has been made by Assmann, Rösler and Weiss, Rosset and Bach, Lutembacher, Bordet, Bedford, and others.

When decompensation is present, the left auricle cannot dilate beyond the di-

shadow is made by the right auricle, and the acute cardiohepatic angle is obliterated by the distended right auricle, and is visualized as a right or obtuse angle (Fig 5).

The following case exemplifies an extreme grade of this condition.

Case 1 S A (Record 642), female, aged 14 years, a Japanese schoolgirl, was one of four children. The child was well and strong until ten years of age, at which time she had chorea, and was sick for one year. Because her pulse was found to be

irregular, and she was markedly dyspneic upon any exertion, she entered the hospital for a complete check-up, at the sug-

pitched, rumbling, systolic and diastolic murmurs were heard over the entire precordia, and were transmitted to the left

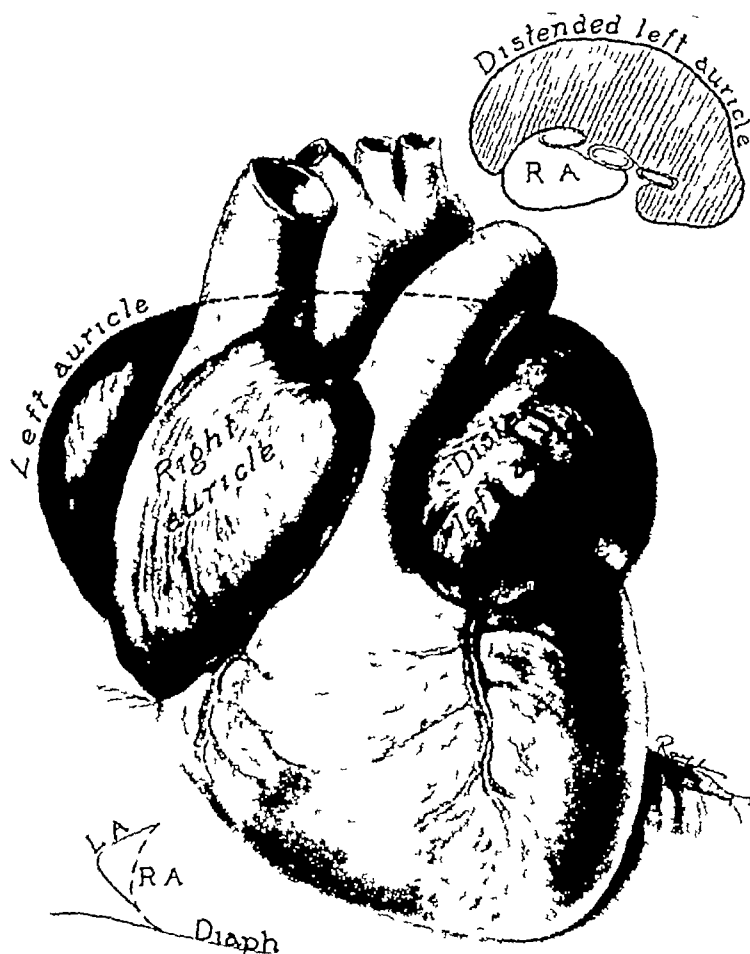


Fig 4 Drawing of an extreme case of dilated left auricle which is shown making up a large portion of the right border of the heart. The relations of the two auricles are shown diagrammatically

gestion of the school physician Three days after admission, the child suddenly died while playing with a doll in bed

Examination revealed a pale, slightly built, undernourished Japanese girl, with no cyanosis and no breathlessness while at rest Her pulse was completely irregular, rate 80 There was a diffuse heaving cardiac pulsation, with apex visible in the sixth interspace at the axillary line, apical diastolic thrill was noted Loud, low-

axilla and back On percussion, dullness was noted to the right of the sternum, and some impairment noted in the right axilla Lung-fields were clear No râles or breath changes were noted There were no signs of congestive failure

Electrocardiogram showed auricular fibrillation, with right ventricular preponderance Blood count revealed secondary anemia, urinalysis was normal

Roentgenograms (Figs 6 and 7) taken at

six feet revealed a marked enlargement of the right heart shadow, the right enlargement being almost as large as the left. The measurement from the mid-line to the right border was 8 cm, and from the mid-line to the left border, 10.8 cm, making a total of 18.8 centimeters. The measurement of the length of the heart in the lateral view was 19.4 centimeters. On the right side, there was a bulging of the shadow beyond the normal border. This same shadow in the lateral view obliterates the retrocardiac space.

Postmortem examination revealed a markedly enlarged heart, with an extremely dilated left auricle (Fig 8), which made up the entire posterior portion of the heart and projected back and to the right beyond the border of the right auricle (Fig 9). Examination of the valves revealed a very high degree of mitral stenosis, with vegetations. In addition to these findings, there was noted a passive congestion in the lungs. The mitral orifice was almost completely closed, admitting only the point of a pencil.

An examination of a number of histories, with an examination of the roentgenograms, at the Los Angeles General Hospital, revealed the fact that cases of mitral stenosis which remain compensated and show an extreme enlargement of the right side of the heart shadow are the result of an enlargement of the left auricle. This causes an acute angle to be formed at the cardiohepatic or diaphragmatic junction. As decompensation progresses, the dilating right auricle obliterates the shadow of the left auricle, as well as the acute cardiohepatic angle, and forms either a right, or obtuse, angle.

In Figure 10 are shown diagrams, drawn to the scale of roentgenograms, of actual cases of mitral stenosis, in varying degrees of decompensation. These diagrams are shown to emphasize the part played by the upper chambers of the heart, in the contour of the heart shadow, as shown by roentgenograms. They illustrate the difference in contour between compensated and decompensated cases, and show the

angle produced by the right border of the heart shadow with the diaphragm.

CONCLUSIONS

- (1) Dilatation of the right side of the heart, as shown and demonstrated by

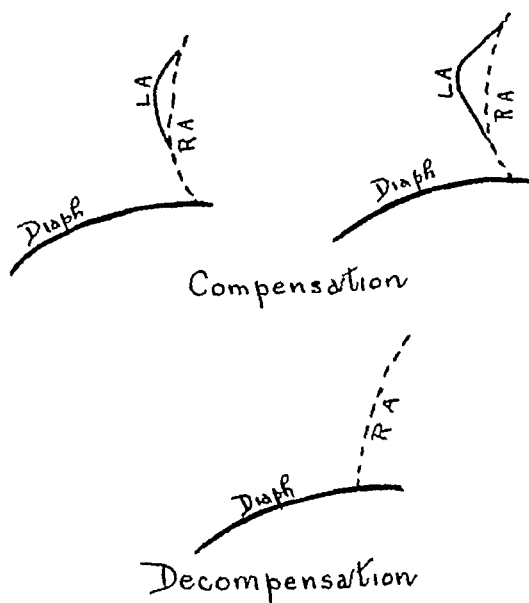


Fig 5

roentgenologic examination in compensated cases of mitral stenosis, is due to enlargement of the left auricle.

- (2) Enlargement of the right side of the heart in decompensated cases, as shown by roentgenologic examination, is due to dilatation of the right auricle.

(3) In roentgenograms of cases of mitral stenosis, the cardiohepatic angle is either acute or obtuse and is in direct proportion to the degree of decompensation. In cases in which compensation is complete, the dilatation of the left auricle causes an acute angle, which will be shown by roentgenograms as the cardiohepatic angle. In cases in which there is a decompensation and a resulting dilatation of the right auricle, the angle is either right or obtuse.

- (4) Description of the roentgenograms should call attention to the cardiohepatic



Fig 6 Anteroposterior roentgenogram, at six ft of chest in Case 1. This shows an extreme bulging of the right heart shadow with aneurysmal pouch of the left auricle. Note extremely acute cardio-hepatic angle.



Fig 7 Lateral view of a six ft roentgenogram in Case 1. Note complete obliteration of retrocardiac space.

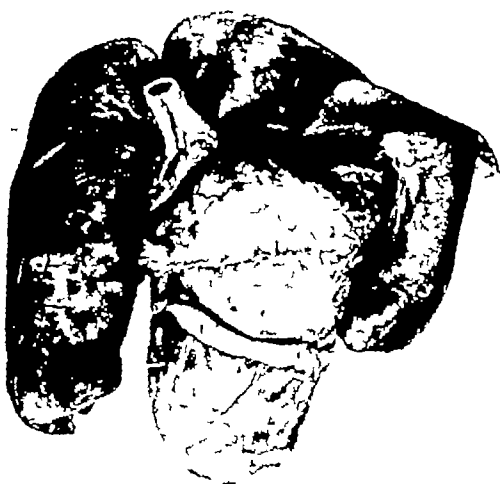


Fig 8 Photograph of heart and lungs in Case 1, posterior view. Note that the entire posterior aspect of the upper chambers of the heart is occupied by the left auricle.



Fig 9 Photograph of heart and lungs in Case 1, anterior view. Note appearance of left auricle extending beyond the right border of the right auricle with the aneurysmal pouch as shown in the x-ray film (Fig 6).

angle, and the presence of compensation or decompensation must be known before

a correct interpretation of the heart contour can be made.

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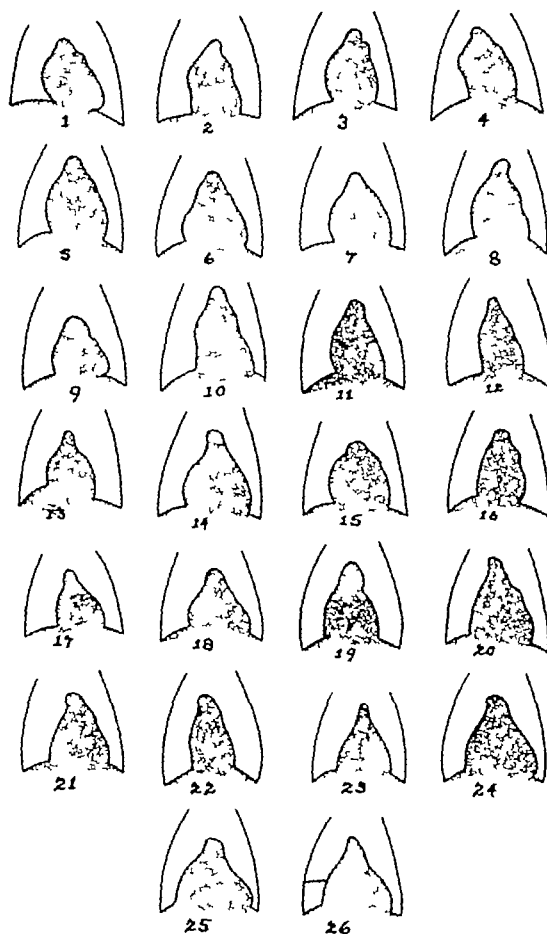


Fig 10 Diagrams of the heart shadow in actual cases of mitral stenosis, in varying degrees of compensation Numbers from 1 to 12 show compensated mitral stenosis, 13 to 16, compensated cases of mitral stenosis that have had a decompensation, 17 to 20, partially decompensated mitral stenosis, 21 to 24, completely decompensated mitral disease, 25 and 26, completely decompensated mitral disease with anasarca

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AIR DENSITY CORRECTIONS FOR TEMPERATURE AND PRESSURE APPLIED TO X-RAY IONIZATION CHAMBERS

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ABSTRACT

The international roentgen is defined only for a given density (as affected by temperature and pressure) of normally dry air. Since ionization measurements are usually carried out at other than the standard density, corrections must be made therefor. These correc-

tions are discussed and their applications are given for (a) standard ionization chamber measurements, (b) calibration of thimble chambers against a standard, (c) clinical use of thimble chambers at other than the prescribed air density, (d) radio active leaks for ionometer sensitivity control, (e) radio active compensators for ion current measurement.

I—INTRODUCTION

THE unit of x-ray quantity, the roentgen,¹ has been defined by international agreement in terms of the ionization produced under stated conditions in a cubic centimeter of atmospheric air. The ionization which a given x-ray beam will produce in a given volume of air is simply proportional to the number of molecules of the air exposed to the rays, that is, proportional to the density of the air. The density of atmospheric air depends upon the following factors: (1) composition, (2) moisture content, (3) temperature, (4) pressure. Air composition is extremely uniform for altitudes up to 15 kilometers and over the earth's surface. Ordinary variations in density resulting from change in composition do not affect the ionization produced in air. A change in temperature of 10° C causes a change in air density due to its moisture content of only about 0.5 per cent. It is, therefore, assumed that air density changes are due entirely to variations in temperature and pressure. The density of unconfined air varies inversely as its absolute temperature and directly as its pressure. The roentgen is,

therefore, uniquely defined when these conditions are given. To fulfill this requirement the definition states that the ionization shall be measured in air at a temperature of 0° C and a pressure of 760 mm mercury, *i.e.*, air having a density of 0.001293 g/c.c.

In formulating this definition it was not, of course, intended that ionometers should necessarily be calibrated nor that dosage measurements should necessarily be made at 0° C and 760 mm pressure, for while not impossible, it would be extremely impractical. It was recognized that, regardless of what temperature and pressure were specified as standard, calibrations and dosage measurements would be made in general under different conditions, and that this would involve temperature and pressure corrections.

Until recently, however, little attention has been given to these corrections, chiefly because they were of about the same order of magnitude as the error involved in the measurements. Now that it is possible to make the measurements within 0.25 per cent, these corrections can no longer be neglected. In the calibration of an ionometer there are three separate temperature and pressure corrections involved. The first is applied to the standard chamber, the second and third to the ionometer reading. These will be discussed in turn and a simplification of the process, arising from the simultaneous application of the first correction factors, will be noted.

¹ The quantity of radiation which when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at 0° C and 76 cm mercury pressure such a degree of conductivity that one electrostatic unit of charge is measured at saturation.

II TEMPERATURE AND PRESSURE CORRECTION APPLIED TO STANDARD IONIZATION CHAMBER

By the definition of the roentgen, ionization due to "wall effects" is excluded. It is, therefore, to be expected that, in the open-air ionization chamber where this condition is most nearly realized, the ionization produced would vary directly as the density of the air. The density d_0 at 0°C (273° , absolute) and 760 mm mercury may be calculated from the density d_t at temperature $t^\circ\text{C}$ ($273 + t$, absolute) and pressure, p , by the equation²

$$d_0 = d_t \left(\frac{273 + t}{273} \times \frac{760}{p} \right) \quad (1)$$

Since, then, the ionization in the open-air chamber varies directly as the air density,

² This equation is an approximation good to about 0.1 per cent. The more exact expression is

$$d_0 = d_t (1 + 0.00367t) \frac{760}{p}$$

number of roentgens, r , should be given by

$$\begin{aligned} r &= I_0 \\ &= I_t \left(\frac{273 + t}{273} \times \frac{760}{p} \right) \\ &= I_t k \end{aligned} \quad (2)$$

Where I_t is the observed ionization per c c in e s u at $t^\circ\text{C}$ and p mm mercury, and I_0 is the corresponding ionization per c c in e s u at 0°C and 760 mm mercury.³

This relationship was tested experimentally first by McClung,⁴ in 1904, and by Crowther,⁵ in 1909, and found to hold within the experimental accuracy. The factor k is the air density correction which must be applied to the ionization, I_t , measured under any fixed conditions of temperature and pressure, in order to

³ To distinguish between I_t and I_0 in (2), Victoreen (RADIOLOGY, November, 1931, p. 1014) refers to I_0 as "roentgens reduced to zero."

⁴ R. K. McClung Phys Zeit, 1904, 5, 368. Also, Phil Mag, 1904, 7, 81.

⁵ J. A. Crowther, Proc. Royal Soc., London, 1909.

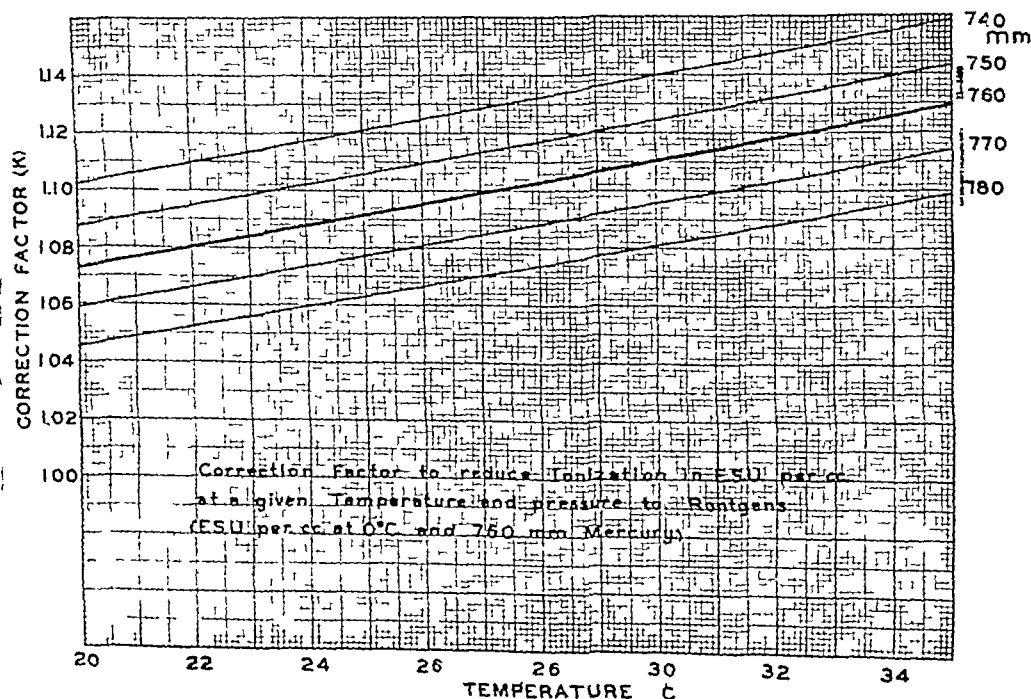


Fig 1

determine the value called for by the definition of the roentgen. Values of k for the range of temperatures and pressures ordinarily encountered are plotted in Graph I. This factor, therefore, enables us to determine the x-ray quantity in roentgens under any condition, for we have simply to measure the ionization per c.c. and then multiply by k to get the ionization in e.s.u. at 0° C and 760 mm mercury pressure. This by definition gives the x-ray quantity in roentgens.

In the preceding discussion of the temperature-pressure correction, as applied to the standard ionization chamber, it is tacitly assumed that the electrostatic measuring system is independent of temperature and pressure. This assumption holds for all deflection systems, and for null systems involving either electrostatic compensators or hermetically sealed radioactive compensators. It does not hold for systems which are not hermetically sealed.

In any radio-active compensator, the current is produced by air ionization which varies according to the same laws as x-ray ionization and, hence, is likewise subject to corrections for air density unless hermetically sealed. In the sealed compensator the density variation is identical with that in the air ionization chamber, so that, when the two are used simultaneously, the air density correction experimentally vanishes. In such a case, however, it is of importance to know the air density for which the compensator calibration was made in order that the readings may be reduced by (2) to the standard density.

III TEMPERATURE AND PRESSURE CORRECTIONS AS APPLIED TO IONOMETERS

Whether the simple air density corrections which apply for the open-air ionization chamber are also applicable to ionization chambers which are not free from "wall effects," is not known with a high degree of certainty. However, pending experimental proof, it has been universally

assumed that the same corrections apply to chambers of the thimble type or others having appreciable "wall effects." The necessity for applying an air density correction when calibrating an ionometer arises from the fact that ionometers are often used at temperatures and pressures other than those at which the calibration is made. If an ionometer receiving a given number of roentgens (r) at known temperature (t_c) and pressure (p_c) gives a scale deflection of θ_c , it would on receiving the same number of roentgens at some other temperature (t_w) and pressure (p_w) give another deflection (θ_w).

$$\theta_w = \theta_c \left(\frac{273 + t_c}{273 + t_w} \times \frac{p_w}{p_c} \right) \quad (3)$$

This correction is applied at the time of calibration of the ionometer against the standard.

Since in general the air density in the clinic will be variable, a second correction to be applied by the radiologist may be necessary. This is required if at the time the ionometer is used the temperature (t_a) and pressure (p_a) differ from the temperature (t_w) and pressure (p_w) under which it was intended to be used. Thus,

$$\begin{aligned} \theta_w &= \theta_a \left(\frac{273 + t_a}{273 + t_w} \times \frac{p_w}{p_a} \right) \\ &= \theta_a c' \end{aligned} \quad (4)$$

Ionometers of American manufacture are calibrated for use at 22° C, 760 mm mercury pressure. For such, Equation (4) becomes

$$\begin{aligned} \theta_w &= \theta_a \left(\frac{273 + t_a}{295} \times \frac{760}{p_a} \right) \\ &= \theta_a \left(2.576 \times \frac{273 + t_a}{p_a} \right) \\ &= \theta_a c \end{aligned} \quad (5)$$

The correction factor in (5) (quantity in parenthesis) is usually obtainable, for the range of temperature and pressure conditions ordinarily encountered, from a chart

supplied by the manufacturer. It may likewise be obtained from Graph II. Ionometers graduated to read roentgens directly can be correct only at the temperature and pressure at which it is intended that they be used. Under other conditions, corrections must be made either by Equation (4), (5) or from the chart supplied by the manufacturer.

It should be emphasized that the radiologist need make only one of the corrections discussed above and then only when high accuracy is desired. For small variations in temperature ($\pm 3^\circ \text{C}$) about the calibrated operating temperature (22°C), the error introduced by neglecting the air density corrections will be only ± 1 per cent. Similarly a variation in atmospheric pressure of ± 10 mm Hg will introduce an error of about ± 1 per cent. The sum of these errors will usually be within the experimental error of an ionometer as used clinically.

IV APPLICATION OF AIR DENSITY CORRECTIONS TO CALIBRATION OF AN IONOMETER

Let it be required to calibrate an ionometer to measure roentgens correctly at a temperature t_w and pressure p_w . The temperature at the time of calibration is t_c and the pressure p_c . The ionization current produced by a constant x-ray beam is first measured by means of a standard ionization chamber which indicates 1 e s u per c c of air per minute. The ionometer is then placed in this beam and after m minutes shows a deflection of θ_c .

Correcting the standard chamber magnitude, the number of roentgens (r) entering the ionometer in m minutes is determined from Equation (2),

$$r = Im \times \left(\frac{273 + t_c}{273} \times \frac{760}{p_c} \right) \quad (6)$$

The deflection of the ionometer θ_w for the specified working conditions (t_w , p_w),

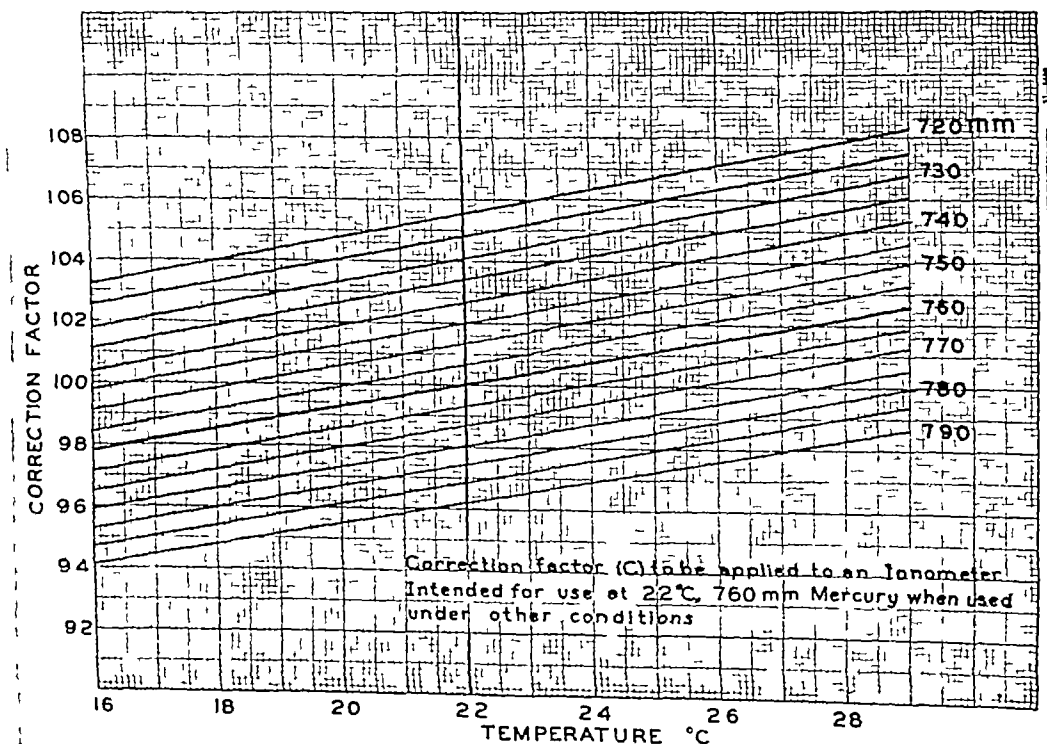


Fig 2

determine the value called for by the definition of the roentgen. Values of k for the range of temperatures and pressures ordinarily encountered are plotted in Graph I. This factor, therefore, enables us to determine the γ -ray quantity in roentgens under any condition, for we have simply to measure the ionization per cc and then multiply by k to get the ionization in esu at 0°C and 760 mm mercury pressure. This by definition gives the γ -ray quantity in roentgens.

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In any radio-active compensator, the current is produced by air ionization which varies according to the same laws as γ -ray ionization and, hence, is likewise subject to corrections for air density unless hermetically sealed. In the sealed compensator the density variation is identical with that in the air ionization chamber, so that, when the two are used simultaneously, the air density correction experimentally vanishes. In such a case, however, it is of importance to know the air density for which the compensator calibration was made in order that the readings may be reduced by (2) to the standard density.

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This correction is applied at the time of calibration of the ionometer against the standard.

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Ionometers of American manufacture are calibrated for use at 22°C , 760 mm mercury pressure. For such, Equation (4) becomes

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The correction factor in (5) (quantity in parenthesis) is usually obtainable, for the range of temperature and pressure conditions ordinarily encountered, from a chart

by means of Equation (3) should be corrected to the conditions of temperature and pressure (t_w , p_w) for which it is intended that the ionometer be used. When at any time the ionometer is to be checked by this control the deflection-time ratio must again be determined for existing temperature and pressure conditions (t_a , p_a) and this ratio by means of Equation (4) reduced to the working conditions (t_w , p_w). By this means a check obtained from a control of this type has a real significance, a good agreement between the initial check and that obtained later (both for conditions t_w , p_w) indicating that the calibration of the ionometer has remained unchanged. Capacity controls have recently been incorporated in certain ionometers which do not require corrections for temperature or pressure.

VI CONCLUSIONS

Of the temperature-pressure corrections

discussed, that to be applied to the standard ionization chamber—correcting from 0° C to room temperature—is by far the most important, under ordinary conditions it amounts to about +8 per cent.

In order to measure dosage accurately by means of an ionometer which has been calibrated in roentgens, the following factors must be known (1) the temperature and pressure for which it is intended that the ionometer be used, (2) the actual temperature and pressure at the time the ionometer is used.

In order to effect an accurate calibration of an ionometer by means of a standard chamber the temperature and pressure at the time of calibration need not be known.

The temperature-pressure correction to be applied to an ionometer will vary from about -2.0 per cent to +4.0 per cent. For extremes in temperature and for the low atmospheric pressures at high altitudes this correction may be as large as +7.0 per cent.

when receiving r (roentgens), should be from Equation (3),

$$\theta_w = \theta_c \left(\frac{273 + t_c}{273 + t_w} \times \frac{p_w}{p_c} \right) \quad (7)$$

The number of roentgens per scale deflection of the ionometer (under conditions t_w , p_w) is obtained by dividing Equation (6) by Equation (7)

$$\frac{r}{\theta_w} = \frac{Im}{\theta_c} \left(\frac{760}{273} \times \frac{273 + t_w}{p_w} \right)^{*6} \quad (8)$$

V TEMPERATURE-PRESSURE CORRECTIONS APPLIED TO RADIO-ACTIVE IONOMETER CONTROLS

Since ionometers are for the most part delicate instruments it is essential that some means be provided for occasionally checking their calibration. Radium or some other radio-active substance is usually provided as such a control. Since the ionization produced by the control follows the same law as for x-ray ionization,

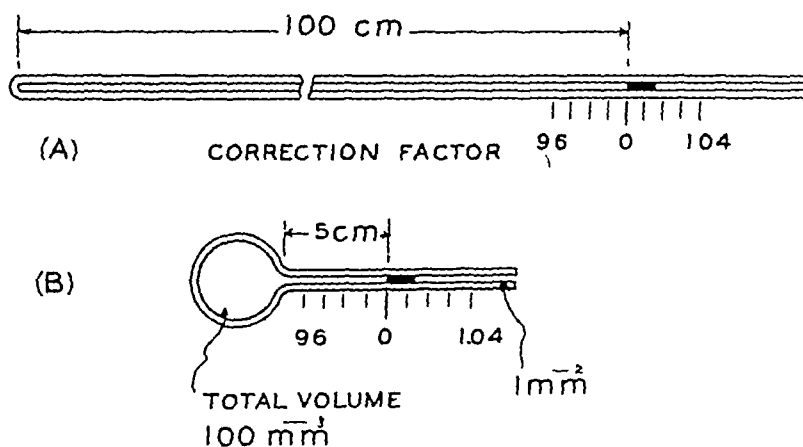


Fig 3

It is of interest to note that Equation (8) does not involve either the temperature (t_c) or pressure (p_c) under which the calibration is made and that there is, therefore, no need for knowing the temperature and pressure at the time of calibration⁷

^{*6} For all ionometers of American manufacture and for those calibrated at the Bureau of Standards t_w is 22° C and p_w is 760 mm of mercury. Equation (8) then becomes

$$\frac{r}{\theta_w} = \frac{Im}{\theta_c} \frac{295}{273} = (1.081) \left(\frac{Im}{\theta_c} \right)$$

⁷ W. Nicholas of this laboratory has suggested and used a simple means of obtaining the air density correction without actually measuring the temperature and pressure. A globule of mercury in a capillary tube sealed at one end (Fig 3-A) will move according to the air density in the tube which will, of course, vary with temperature and atmospheric pressure. If, for example, the tube has a uniform cross-section and the

similar temperature and pressure corrections are applicable

It is, therefore, recommended that air density corrections on radio-active controls be made in the same manner as the corresponding corrections applied to ionometers. At the initial calibration, the scale deflection produced by the radio-active control per unit time (ratio of deflection to time) should be found, and

globule is 100 cm from the sealed end each centimeter of motion of the globule will represent about 1 per cent change in air density giving directly the correction necessary to apply to the ionization readings. A modification of this suggestion would be to replace the long tube by a capillary and bulb of known volumes (Fig 3-B) so as to reduce the size of the apparatus. Such a device may be mounted directly on an ionometer for convenience.

served in the superior duodenum which are fixed by the hepato-duodenal and hepato-colic ligaments which maintain this deformity. Inasmuch as there are two fixed points in the superior duodenum together

manipulation under the fluoroscopic screen. Manipulation of the duodenum with the gloved hand is an important procedure which should be routinely employed in the investigation of the duodenum. The visu-

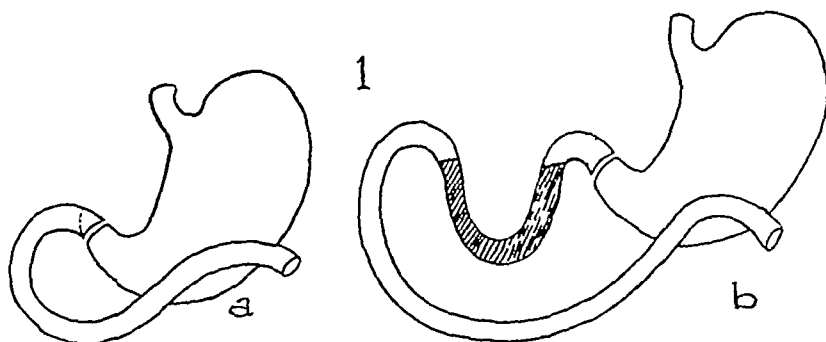


Fig 1 Diagrammatic drawing (a) of the normal duodenal curve, (b) illustrates the redundancy of the superior duodenum. Note the two fixed points at the two angulations. The shaded area is the redundant loop producing the water-trap effect, which retards the flow of the contrast meal. Duodenal stasis occurs in this loop.

with unusual lengthening, a ptosis in the mid-portion of the lengthened segment is produced, forming a loop characteristic of a water-trap. The resulting deformity of this anomaly is revealed as a "U," "V," or "M" shape of the superior segment. Instead of the marked ptosis of the redundant part, occasionally, a slight sagging or serpentine form may be noted.

It is important when making the examination to place the patient in the proper position, this anomaly is best observed in the erect posture. In most instances the oblique projection brings the malformation of the duodenum into view, inasmuch as the duodenum is nearly always directed posteriorly in this affection. On this account the extra loop may be overshadowed by the pylorus or other portions of the duodenum. Frequently the redundant loop may not be visible in the anteroposterior position, and occasionally appears to coalesce with the cap or descending arm of the duodenum and thus may pass unrecognized. The picture at first glance may appear to be due to an enlarged duodenal bulb or a diverticulum, but these may easily be eliminated by

visualization of the entire duodenum is extremely important since other abnormalities may be found associated with redundancy. This anomaly has been variously described as a ptosis, festooning, idiopathic elongation, *M*-deformity, or extra looping.

Considerable interest has been manifested in this malformation because of its association with the disturbance of motility of the duodenum, resulting in the production of duodenal stasis, irritable duodenum, duodenitis, and frequently with ulceration. As a result of prolonged stasis in the duodenum it is not difficult to picture how this factor may easily play an important rôle in the production of such disturbances. Therefore, this anomaly should be given careful consideration, as an early recognition is highly essential in order to eliminate the possibility of associated complications. Duodenal stasis varying from a slight to a moderate degree was observed in every instance. No marked or unusual stenosis was detected. The stasis, which in this instance is due to the ptosed loop which retards the flow, differs from the usual type in that it occurs only in the loop, while the remaining duodenum

REDUNDANT DUODENUM. A ROENTGENOLOGIC STUDY¹

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MUCH has been written in recent years on duodenal anomalies. The roentgen-ray examination offers a reliable method for a thorough investigation of the duodenum. Abnormalities of this portion of the small bowel are frequently overlooked, principally because of the fact that the examiner concentrates his attention on the first part of the duodenum. It is quite probable that were the entire duodenum studied with the same meticulous care, many more instances would be discovered. Anomalies of the duodenum are far more common than is indicated by a survey of the literature. Of these, the redundant duodenum is of especial interest. It is a condition in which there is usually an elongation of the superior portion of the duodenum with a ptosis of the mid-portion of the superior segment resulting in an anomalous loop. Recently (1,2) we have called attention to this malformation and its clinical significance, and have established this anomaly as a roentgenologic entity.

The normal duodenum, about 27 cm in length, has a definite anatomic configuration in the form of a "C," or incomplete circle. In this anomaly the superior aspect of the duodenum is lengthened. The duodenum lends itself easily for roentgen examination, and any abnormality may readily be disclosed by this method of investigation.

The duodenal cap or first portion of the duodenum which normally represents the superior duodenum is surmounted upon the pyloric outlet. It is about 5 cm in length and presents itself in the form of a cone, with its base at the pylorus and apex forming the first duodenal angle. From the apex, the duodenum as a rule makes a

sudden drop and is usually directed to the right of the cap and somewhat posteriorly. It is held in place by the hepato-duodenal ligament, which represents the free margin of the lesser omentum. In the redundant duodenum the normal configuration is quite altered because of the marked elongation of the superior segment. Any portion of the duodenum may be involved, but this malformation is more commonly found in the superior part. Since the superior duodenum is lengthened, another angle is formed to the right of and posterior to the first angle, which is held in place by the hepato-colic ligament. The distance between the two angulations varies according to the length of the superior duodenum and the size of the ptosed loop. The elongated portion of the superior duodenum varies in length from 5 to 10 cm, which measurement is exclusive of the bulb. In some instances sharp angulations may exist, but no instances of prolapse of the angles were observed in this study. The resultant picture, as viewed roentgenologically, is a deformity of the superior segment, forming a water-trap effect in which the flow of the contrast meal through the duodenum is delayed.

The incidence of this anomaly in the routine gastro-intestinal roentgen examination is rather small, occurring in about 2.5 per cent in our series of cases.

Roentgen Examination—The fluoroscopic method of examination is the procedure of choice, giving by far the best visualizations of this anomaly. The duodenal cap or bulb is usually normal in size, but may occasionally be elongated. Beginning at the apex of the cap, the duodenum, instead of making a sudden drop to form the descending arm of the "C," is lengthened in its superior aspect, forming an extra loop. The descending arm of the duodenum is displaced to the right and posteriorly. Two angulations are ob-

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the position of these organs bear no special relationship to redundancy of the duodenum

The diagnosis of this anomaly must be based almost entirely upon a thorough roentgenologic examination. Although the condition is best recognized by fluoroscopic examination, it may also be recorded upon roentgenograms when the patient is placed in the proper position. The fluoroscopic study most satisfactorily reveals this anomaly in the upright posture, viewed anteroposteriorly, obliquely, and laterally. The puddling of the barium meal in the extra loop is the most striking picture, which at once gives a clue as to the presence of a redundant segment of the duodenum. On manipulation the puddling disappears only to return on the next spurt of barium. A double fixation of the superior duodenum is presented in this group of cases which represents a congenital anomaly. This fixation is due to the presence of peritoneal bands, represented by the hepato-duodenal and hepato-colic ligaments.

Roentgenologically, the redundant loop may be simulated by a number of conditions, such as accessory pocket of a duo-

denal ulcer, inverted duodenum, dilated duodenal bulb, duodenal diverticula, filled ampulla of Vater, duodenal adhesions, periduodenitis, and various other duodenal distortions and deformities.

SUMMARY

A roentgenologic study of the redundant duodenum is presented. This anomaly, which occurred in about 2.5 per cent of 500 routine gastro-intestinal roentgen studies, is far more common than is indicated from a survey of the literature. It is a roentgenologic entity. The superior portion of the duodenum is the most common segment involved. The malformation produces a looping of the redundant duodenum which results in a water-trap effect, and presents a characteristic roentgen picture. Particularly significant is the association of duodenal stasis and irritable duodenum, with frequent occurrence of ulceration.

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is perfectly normal. Usually there is no dilatation of the lumen. The stasis noted in this anomaly simulates a water-trap in which the fluid remains at a certain level, even after the duodenum is completely

denal cap, though normal in size, revealed evidence of irritability. In many instances the cap showed a fibrillation, transient irregularities, and shifting spastic defects. Frequently it was difficult to

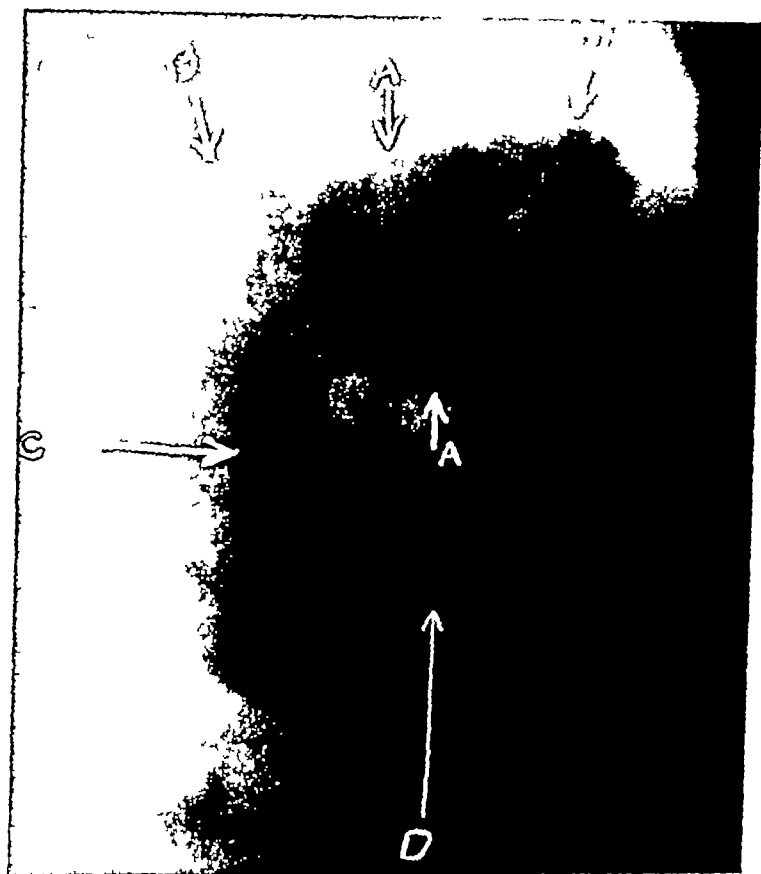


Fig 2 Roentgenogram demonstrating the typical picture of the redundant duodenum. The two fixed points in the superior duodenum, the two angulations, the extra loop, and the stasis are clearly shown.

emptied. Gastric motility was not unduly interfered with, and no gastric retention occurred in our study. No unusual or exaggerated retro-peristalsis was detected. True writhing was not observed, though a slight swaying motion was at times noted in the loop.

Duodenitis was found to be associated with this anomaly in a number of instances, while evidence of marked duodenal irritability was noted in all cases which came under observation. The duo-

denal cap, though normal in size, revealed evidence of irritability of the duodenum from the true form of duodenitis.

The presence of gastric and duodenal ulceration associated with this malformation is a very significant observation. Ulceration occurred in slightly over 41 per cent of the cases in this series.

It was of interest in this study to determine the relation of the position of the stomach and colon to the redundant duodenum. This investigation revealed that

garding the results of honest errors in treatment or diagnosis *The law does not expect us to be infallible and makes due allowance for the possibility of humans to err* There are numerous decisions from courts in all parts of this country, which state in exactly so many words that, "A physician is not an insurer of a cure" or of good results from his treatment or for the correctness of his diagnosis Consequently, we are not held liable for honest errors of judgment if our methods are along recognized lines, and we have exercised the usual and proper amount of care and skill in the application of these methods Many State Supreme Courts have rendered decisions which are unusually clear and fair to the medical profession, in their interpretation of the statutes, common law, and other decisions (judge-made laws) in this regard It has been the writer's privilege to have appeared as a witness several times in the defense of physicians charged with malpractice, and to have advised regarding the conduct and defense of cases on numerous other occasions for alleged malpractice, and we are glad to say that we have found that nearly all of the presiding judges in the trial courts in Illinois, Indiana, Iowa, Michigan, Nebraska, Ohio, Pennsylvania, and Wisconsin where we have been, are amenable to the application of common sense principles and fair mindedness in this particular regard at least

RES IPSA LOQUITUR?

The doctrine of "*Res ipsa loquitur*" (the thing speaks for itself), when applied to a roentgen-ray injury, is one of the far-too-often-used dicta of the prosecuting attorneys It has been decided in some States that this doctrine cannot apply when the alleged injury appeared after the use of the roentgen rays for therapeutic purposes, but may apply when the roentgen rays were used for diagnostic purposes In a few States it has been held by the highest courts that this doctrine cannot apply at all, and in other States (Washing-

ton, notably),³ "The court may refuse to apply that rule in its instructions" It has been the writer's contention that this doctrine should never apply in this sort of case, and we have been able to help some in convincing courts to that effect However, it is occasionally so evident—when a roentgen dermatitis appears after the use of the x-rays in a diagnostic procedure—that "the thing speaks for itself" (or, as the lawyers have it, *Res ipsa loquitur*) so that unquestionably there may be occasionally a real responsibility with the radiologist, and, try as we may, errors occur, dermatitis result, undeniably, damage is done and these cases come up It is surprising that the lay technicians who are doing so much of this work on their own responsibility do not have more of these injuries than they do Their apparent freedom must be due to what the Germans speak of as "*Mehr Glück wie Verstand*"

RESPONDEAT SUPERIOR

In regard to the responsibility of physicians and surgeons who are employed either full or part time by hospitals, corporations, or clinics, the courts are nearly unanimous in holding that the doctrine of "*Respondeat superior*" (the master is responsible) does not apply This is unquestionably sound and logical, because in the performance of our professional duties we are not subject to rules and instructions as regards how and when we should perform those duties, as are other employees, and the employers must in the natural order of things rely and depend entirely upon our judgment, for which they should not rightfully be held responsible in the event that we err or fail to apply the necessary degree of skill, knowledge, or judgment Among some of the recent decisions voicing this opinion are *Borgeas vs Oregon Short Line Ry Co, et al* (Ore), 236 Pac R 1069, *Parsons vs Yolande Coal & Coke Co* (Ala), 91 So R 493, *Black vs Fischer et al* (Ga), 117 S E R 103 and *Morrison vs Henke et al* (Wis), 160 N E R

³ *Stuckney vs Congdon et al*, 228 Pac R. 849

THE RELATIONS OF THE RADIOLOGIST AND THE LAW¹

By I S TROSTLER, M D, F A C R, F A C P, Chicago

THE relations and responsibilities of a radiologist to the law are as a general subject and in a general way, not much more nor less than those of any other medical specialist

A medical specialist is legally defined as a physician who applies himself to the study and practice of some particular branch of medicine. Being employed by patients or those representing them, because of his peculiar or particular skill and knowledge in that branch of medicine, it naturally follows that his duty to his patients is not measured by the ordinary or average skill and knowledge of physicians, because if he possesses no greater degree of skill or amount of knowledge in his specialty that does the average physician, there would be no reason or motive for his employment, and possessing such additional and greater degree of skill and amount of knowledge it naturally becomes his duty to apply it

Briefly and succinctly, the standard of skill and knowledge required by the law of a physician who holds himself out as a specialist, is that degree of skill and knowledge which is ordinarily possessed by physicians who devote special attention to the same specialty, under similar conditions and in similar or like locations, and with regard to the present state of medical knowledge. Accordingly, a radiologist who undertakes to make roentgen diagnoses or administer roentgen or other radiation treatment, must exercise in such diagnosis and treatment, the same degree of care, skill, and knowledge as is customarily and usually exercised and applied by radiologists in good professional standing in the same or a similar locality

Incidentally, *it would be well if this test of skill and knowledge was applied to all who*

hold themselves out as radiologists, and who accept employment as such, whether they are licensed physicians or mere pretenders, without medical education

ESTABLISHED METHODS OF PRACTICE MUST BE FOLLOWED

One of the most rigid rules regarding the practise of medicine, and one pointed out and mentioned in many important legal decisions involving this subject, is that *physicians must follow established methods of practice*. If a physician departs from recognized remedies or methods of treatment or of diagnosis, it is at his own peril and risk, and if such departure results in injury to the person so treated, the physician will be liable for damages however good his intentions may have been. A very good example of how this subject is viewed from the legal side is embodied in the following quotation from a decision by the Wisconsin Supreme Court²: "In cases where there can be said to be a thoroughly established and usual method of treating a situation, meaning thereby that a certain mode of treatment has been recognized, adopted, and followed by all physicians and surgeons of good standing, *a departure therefrom would be clearly at the risk of the physician venturing to make the same*"

It is, of course, obvious that in order to make the physician liable because of a departure from established methods, such treatment or departure from established methods must have some deleterious effect or in some way have injured the patient, and *this must be proven*

THE LAW ALLOWS FOR ERROR

A subject not infrequently brought up for discussion in malpractice suits is re-

¹ Read before the Chicago Roentgen Society, March 3 1933

² Allen vs Voje 114 Wis 1 89 N W R 924

Exceptions to this ruling occur, however, one such case being *The Lincoln Park Coal and Brick Co., vs Industrial Commission et al* (Ill), 148 N E R 79, where an employee was required to have a roentgenographic examination made by the coal and brick company's physician. In this case the supreme court looked upon this physician as the agent for and of the employer and the court decided that the employer was responsible for the alleged roentgen injury. Other decisions holding similarly are *Garrison vs Everett et al* (Neb), 199 N W R 30, which was a drainage tube case, *McMahon vs Carolina Spruce Co* (N C), 105 S E R 439, a fracture case and *Brown vs Sinclair Refining Co* (Okla), 206 Pac R 1942.

In *Wetherington vs Jennings* (Mass), 149 N E R. 201, the Supreme Judicial Court of Massachusetts decided that the radiologist in charge of the x-ray department of a hospital was not responsible for error on the part of the technician who administered a roentgen treatment and left out a filter. Both the physician and the nurse were employees of the hospital but the technician was not in the employ of the physician, who was the defendant in this case. Manifestly he should not be held responsible for the acts of a fellow-employee, even if he wrote the prescription for the treatment, especially if his prescription was not properly filled.

OWNERSHIP OF THE ROENTGENOGRAMS

The position of the roentgenologist in regard to the question of the ownership of the films or plates has come up for more or less discussion for many years, and until quite recently has never been decided by any court of record. Several decisions have been recorded wherein it has been adjudicated that photographic negatives belong to the person, firm, or corporation who made them, and the writer has on several occasions been the cause of the withdrawal of legal proceedings aimed to force the delivery of roentgenograms to plaintiffs in malpractice suits, by merely

quoting these decisions, and our own arguments which have been expounded at numerous times before medical meetings.

Recently, however, two decisions by Michigan courts seem to put the ownership clearly and flatly in our hands, where the same rightfully belongs. We have for years maintained the position that all negatives, plates, films, prints, etc., are as much a part of the records of the case as are the history sheets, and that as such they are the property of the physician, hospital, laboratory, or clinical group that caused them to be made. No court or attorney has thus far deemed it wise to force any contrary action, although several times we have been threatened with legal action. To fortify our position in this particular, it is only necessary that we have all our bill heads and statements read "Roentgen examination" instead for "films," "plates," or "pictures." If that is done, we have the evidence that the examination was what was charged for and naturally the records should remain in the hands of the maker of them, just as does the record of blood counts, etc.

WE MAY REFUSE TO RENDER SERVICES

Like all other physicians, a radiologist may decline or refuse outright to render services, and he is not legally required to render his services should he for any reason prefer not to do so.

However, if he has agreed to render services, he has assumed a contract so to do and he is liable for any damages which may result from a failure to fulfill or complete his contract.

Any physician in undertaking to treat or diagnose the condition or ailment of any patient, by implication contracts and agrees that he possesses a reasonable amount of skill and knowledge, and that he will apply that skill and knowledge with ordinary care and diligence. If there is any doubt, he is required to use his best judgment. All of these statements apply to radiologists, and, in addition, they are, as specialists, expected to have more than

would lead one to construe injury as a direct factor and it is notable that in several cases first attention was drawn to the existence of the disease by some such cause. In Simmond's case a fracture of the arm seems to have played a rôle, while in two of Versé's cases there seems to have been antecedent trauma. In his first case, the lumbar spine was injured and it was there that the most marked pathologic changes were later found, in the second case, a rib was fractured by a blow in the chest."

The presence of Bence-Jones albumosuria is a helpful diagnostic point, but it is not altogether pathognomonic of multiple myeloma. Kahn quotes Boggs and Guthrie, who expressed a view that Bence-Jones proteinuria is not essentially dependent upon one disease, but is a manifestation of disturbances of bone marrow affecting endogenous metabolism.

Differential diagnosis is clinically necessary from special varieties of tabes dorsalis, metastasis from the adrenals, breast, thyroid, or lung, osteomalacia, Paget's disease, syphilis of bone, multiple endothelioma, Hodgkin's disease, and lymphosarcoma. Since multiple myeloma may occasionally accompany other malignancies, especially breast carcinoma, the differential diagnosis may be most difficult.

The prognosis is poor. The duration of life has varied from eight months to from eight to eleven years, with an average of less than two years. Death has occurred from pneumonia and from asthenia. X-ray treatment in light doses relieves the pain markedly and may prolong life. Belden, in 1925, reported the case of a woman of 58, who for three years had had numerous pathologic fractures, which united rapidly and well. Progressive secondary anemia and Bence-Jones bodies were present. The patient was still alive at the time the case was reported.

In the New York City Cancer Institute, Department of Hospitals, we have had about 9,500 admissions since the inception of the Institute in 1923, with 127 primary bone tumors, among which were

seven cases of multiple myeloma. Of these, three had positive biopsy or autopsy findings, and in the others the diagnosis was indicated by the clinical findings. The writer, in over ten years' experience in charge of the X-ray Department in the U S Veterans' Bureau, New York City Regional Office, has had only one case of multiple myeloma in about 60,000 x-ray examinations, showing the rarity of the condition in clinics and departments where cancer is not the paramount issue.

CASE REPORTS²

Case 1 B E, No 5,763, white, male, medical student, admitted July 24, 1929, complained of a swelling on the left side of the chest and pain in the left chest, which was constant and increased on deep inspiration. He was treated for pleurisy until the swelling grew larger. In February, 1929, the tumor on the left side of the chest had been removed at Israel Zion Hospital. On operation, a soft spindle-shaped tumor, adherent to the fifth rib and invading the muscles and periosteum, was excised and the rib curetted. Laboratory examination showed the tumor to be a myeloma. While in hospital, the patient developed a hematogenous nephritis. He was often seized with severe attacks of pain in the lumbar region, accompanied by a board-like rigidity of the abdominal muscles. X-ray examination of the genito-urinary tract revealed no urinary calculi. Following this, the entire skeleton was x-rayed and found to be negative. The patient received x-ray therapy to the chest and back, and the pain in the chest and lumbar region subsided. After he left the other hospital on March 12, 1929, he began to lose weight rapidly and became so weak that he was forced to remain in bed. He had frequent high temperature and sweats. During the next few months he had frequent attacks of pain of a drawing character in both thighs and in the right lower chest, the latter worse upon

² These cases are from the New York City Cancer Institute.

MULTIPLE MYELOMA¹

By DAVID E. EHRLICH, B A , M D , *New York City*

From the New York City Cancer Institute, Department of Hospitals, Ira Kaplan, M D , Director

MULTIPLE myeloma is a primary malignant tumor of the bone marrow, characterized by multiple foci, pain, spontaneous fractures, Bence-Jones albumosuria, anemia, and asthenia. It occurs chiefly in the ribs, spine, sternum, and pelvis of adults. It is uncommon in occurrence, insidious in onset, difficult to diagnose, and the prognosis is hopeless.

Historical—Bence Jones, in 1846, first isolated a body in the urine which now bears his name. The disease was first described by MacIntyre, in 1850, under the term "mollities ossium." The name "multiple myeloma" was given by Von Ruzizky, in 1873, to the Bence-Jones proteinuria and the multiple bone tumors. Kahler gave a remarkable description of the disease in 1884 and many still call it by his name. In 1905, Woods was able to collect 30 cases, in 1907, Permin had found only 40 cases, and Martini, in 1916, collected 204 case records. With the more extensive use of the x-ray, diagnosis was made more simple and, in 1927, Geschickter and Copeland collected 425 cases, 13 of which were their own.

Pathology—Grayish and reddish masses appear simultaneously in spongy bone or in the medullary canal and, as they slowly grow, excite active resorption of the bone. Subsequent bending and breaking of the bone take place, due to the loss of mineral salts. Gradual thinning and perforation allow pathologic fractures to occur, though they are accompanied by little or no pain and are followed by soft tumor masses over the bone. William G. MacCallum, in 1901, arrived at the following conclusions concerning multiple myelomas: "The tumors are distinguishable from other ma-

lignant tumors by their mode of growth and the absence of metastases, myelogenic sarcomas in particular by their multiplicity and the uniformity of their component cells, giant cells and spindle cells being practically absent. The resemblance of the myeloma cells to those of the bone marrow and, especially the great macroscopic resemblance of the tumors to the adjacent bone marrow, from which they can scarcely be delineated, have given rise to the opinion that they spring from some of the bone marrow cells."

Codman, in 1925, subdivided multiple myeloma into four groups: (1) lymphocytic, (2) myelocytic, (3) erythroblastic, (4) plasma cell. In 1927, Longcope added a fifth group, the myeloblastic type. Nephritis is common. Some cases of amyloid degeneration of the spleen, liver, and kidneys are noted. No soft-tissue metastases are made out, although direct contiguous soft-tissue invasion is possible.

Roentgenology—The lesions are seen to be punched-out, rarefied areas, not confluent, varying in size, and widely scattered through the skeleton. The cortex is not destroyed, but expansion of the shaft may be noted. Pathologic fractures are common.

Diagnosis—The condition occurs in patients from 40 to 60 years of age, predominantly in males. Onset is insidious, beginning with vague rheumatic pains, more common in the back. Whitlock, in 1924, suggested that these back pains are caused by erosion of the periosteum or adjacent nerves. In many cases there is a previous history of typhoid or malaria. In cases in which pain is absent or minimal, the roentgen findings may be noted during roentgen study of some internal organ or examination following trauma. Kahn, in 1914, stated "Often the sequence of events

¹ Read before the Radiological Society of North America at the Eighteenth Annual Meeting at Atlantic City Nov 28-Dec 1, 1932

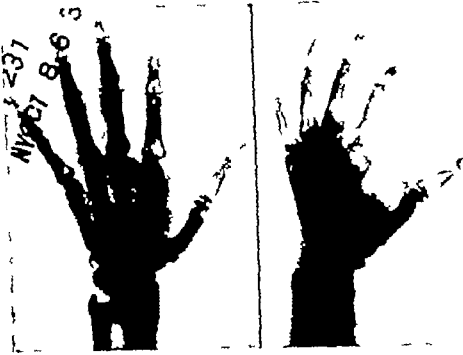


Fig 1 Case 2 Fusiform cystic enlargement in the head of the right second metacarpal, with distal destruction of the cortex



Fig 2 Case 2 Irregular rarefied circular area in sternum just below the angle of Ludwig

nation of the sinuses showed right pansinusitis

On March 22, 1930, biopsy from nose lesion (slide borrowed from Manhattan Eye, Ear, and Throat Hospital) was diagnosed as large round-cell sarcoma by Dr Douglas Symmers, Director of Division of Pathology, Department of Hospitals

On May 16, 1930, and again on Oct 24, 1930, x-ray examination of the chest showed irregular tuberculous productive changes in the upper portions of the upper lobes. Therapy consisted of intra-nasal radium, with several applications of a nasal sound (280 mc-hrs on April 9, 1930, and 1,157 mc-hrs on April 12, 1930). X-ray therapy was administered to the face and nose (2,400 r) from March 22, 1930, to April 5, 1930, while 2,400 r more were given from Jan 26, 1931, to Feb 27, 1931, because of recurrence of bleeding.

On Aug 6, 1931, the nasal condition was improved. Examination showed a slight redness of the mucosa of the right naris, a protuberance about 1×0.5 in, hard, irregular, and bony in consistency, was noted in the upper part of the sternum and to the left of the midline, another protuberance, flatter, but of about the same consistency, shape, and appearance, an inch below the first, but more in the midline, a hard and tender swelling of the right hand just at the proximal joint of the index finger (the patient gave a history of

striking that part of the hand about three months before)

X-ray examinations in August, 1931, showed an irregular localized type of rarefaction in the middle and outer portions of the right clavicle and the sternal end of the left clavicle (Fig 1). In the head of the right second metacarpal and adjacent part of the shaft, there was seen a fusiform enlargement of irregular cystic multilocular type, with destruction of the cortex distally. The proximal phalanges showed a similar but more localized rarefaction without cortical involvement. The same was seen in the lower end of the right radius (Fig 2). The sternum showed an irregular, circular, rarefied area just below the angle of Ludwig, and a similar deposit was made out in the left ischium, in the body of the last lumbar vertebra, and in both tibiae, where the lesions appeared larger in size.

On Aug 28, 1931, the protuberances were seen to be growing larger, and a redness and swelling were noted on the right inner anterior surface of the middle of the tibia. To palpation, it was warm and tender, signs which, the patient said, accompanied the lumps on the chest wall (Fig 3).

X-ray therapy was given to the legs, sternum, and right hand (2,400 r) from Sept 23, 1931, to Oct 26, 1931.

Further x-ray examination on Oct 5, 1931, revealed numerous punched-out

respiration and pressure. In June, 1929, he received another series of radiation to the chest, neck, and head, but the pains did not subside. The rest of the history is irrelevant.

Physical examination showed an emaciated, anemic young man, who appeared to be very weak. The lower right portion of the chest appeared to be widened anteriorly and laterally, with tenderness to pressure over this area. In the left side, there is a post-operative scar, 3.5 inches long, between the fourth and fifth ribs. A portion of the fifth rib appears to have been removed and in its place a newly formed bony disc may be palpated. The abdomen shows rigidity of the recti muscles. Otherwise the physical examination is negative.

Progress Notes—On July 25, 1929, urinalysis showed urine negative for albumin, sugar casts, and red blood cells; specific gravity, 1.008. Sputum was negative for tuberculosis.

On July 26, 1929, x-ray examination of the chest and skeleton (including skull) showed an increase in the vertical diameter of the left fourth and fifth ribs, with irregular rarefaction of punched-out variety. This was seen in lesser concentration, scattered through the rest of the ribs. Irregular productive tuberculous foci were noted in the apices.

On July 28, 1929, the blood count was as follows: Hemoglobin, 55 per cent, red blood cells, 3,000,000, white blood cells, 3,200.

On Aug. 5, 1929, no change was noted in the general condition, the patient running an irregular type of fever. A small exostosis was felt in the temporal region.

On Aug. 21, 1929, cystoscopy showed normal findings, except that urine from the right ureter had a pinkish tinge. Urea, right kidney, 9 per cent, left kidney, 10 per cent. Microscopic examination, right side, few red blood and epithelial cells, left side, the same but slightly fewer in number. Gastro-intestinal x-ray examination showed gastric atony, but no or-

ganic lesion of the stomach. A slight non-productive cough was noted.

On Aug. 25, 1929, the patient coughed up blood-tinged mucus and a few crepitant râles were heard over the right apex.

On Aug. 26, 1929, an x-ray study of the chest showed no change in the rib condition, but an increase in the lung involvement was noted. Wassermann test was negative. On this day the patient was discharged at his own request.

Comment—The age of this patient is exceptional for multiple myeloma. Otherwise the clinical course and symptomatology conform to the typical story.

Case 2. M. C., No. 6,303, policeman, age 55, was admitted March 14, 1930, with a complaint of slight bleeding in the throat, dripping down from above onto the tongue, bleeding from the nasal pharynx, and occasionally in slight degree from the right nostril. The condition had begun five months before admission, the frequency of the hemorrhages increasing with time. For the year previous to admission he had been troubled with increased lacrimation of the right eye. There was no history of trauma about the nose. The case had been referred from the Manhattan Eye, Ear, and Throat Hospital, where biopsy had been performed. The patient's past history was as follows: appendectomy and peritonitis, ten years previously, glands removed from right side of neck, twenty years previously. The family history was irrelevant. The local condition showed that in the right nasal fossa, at the anterior end of the middle turbinate, there was a large area covered with dry blood, the left nasal fossa was somewhat reddened, otherwise normal, the throat and tonsils were somewhat reddened, the larynx was somewhat swollen, no palpable glands were felt in the neck, there was a firm fullness in the left supraclavicular fossa. The sputum was negative for tubercle bacilli. Numerous streptococci (in short chains) and diplococci were found.

Progress Notes—On March 14, 1930, Wassermann and Kahn tests were negative. On March 18, 1930, x-ray exami-

joint A tumor at this joint had been removed at Mount Sinai Hospital four months before and he was able to make his way about on crutches A slide made at the time of biopsy, borrowed from Mt Sinai Hospital, shows reticulum cell lymphosarcoma Five weeks before admission, the right knee began to swell and became tender On admission, he was unable to move the knee or to endure pressure of the palpating hand For about twenty years the patient had complained of indefinite gastric distress Physical examination showed a well nourished adult male, lying quietly in bed Any motion of the lower extremities caused excruciating pain There was a two-inch linear scar over the inner malleolus of the left ankle The right knee showed a fusiform swelling over all aspects, with extreme tenderness extending down the anterior surface of the right leg to the middle third There was a small protuberance about two inches above the outer end of the right eyebrow, no tenderness of the skull, a soft nodule, apparently a sebaceous cyst about two-thirds of an inch in diameter, was situated about the left labionasal fold There was pain on pressure over both humeri, femora, and iliac bones

Progress Notes—The patient received x-ray treatment at Mount Sinai Hospital over both ankles, the right inguinal area, and the right elbow from July 31, 1930, to Jan 8, 1931

The x-ray report of Feb 3, 1931, reveals generalized destructive bone changes throughout the skeleton, including the skull (Figs 4, 5, and 6)

On Feb 11, 1931, the Wassermann test was negative On Feb 12, 1931, the patient experienced increased pain all over the skeleton

On Feb 19, 1931, he was moribund and cyanotic and the next day he died

Comment—In this case, the clinical course favors the impression of multiple myeloma However, there is a division of opinion, from the microscopic study, in the differential diagnosis between reticu-

lum cell lymphosarcoma and reticulum cell multiple myeloma

Case 4 G H, colored male, age 42 years, admitted Oct 21, 1931, with the chief complaints of pain in the back and right hip following injury six months before, and weakness In April, 1931, the patient fell down a flight of basement stairs, striking on his right hip He was confined to bed for about two weeks, after which the doctor sent him to the hospital, where he was kept in bed for three months The patient continued to have pain in the lower spine and right hip No incontinence no blood in the urine At time of admission to the New York City Cancer Institute he felt a little better but could not walk unless he had support There was no loss of weight, the bowels were regular Physical examination showed an obese colored man, appearing to be lame The head was negative, there was no adenopathy in the neck nor thyroid enlargement The chest was negative, the heart and lungs were clear, the abdominal wall was so very thick that palpation was unsatisfactory, no masses were detected There was an ovoid, slightly movable and tender mass in the right groin, measuring about 1×1.5 inch, which was apparently the right testicle that was missing from the scrotal cavity, the left testicle was normal Rectal examination of the prostate showed it to be enlarged, but not hard, there were no lesions in the rectal wall

Progress Notes—On March 28, 1932, following a course of x-ray treatments, the patient stated that the pain in the small of the back had diminished

X-ray examinations (Fig 7) on Sept 29, 1931, and Oct 7, 1931, showed an irregular extensive rarefaction in the pelvis and femora and also in the shafts of the humeri and in the scapulæ A localized area appeared in the lower end of the left ulna (The patient was referred to us for x-ray diagnostic work from a City Hospital Dispensary and was subsequently admitted to our Cancer Institute on Oct 21, 1931)

On Nov 5, 1931, x-ray examination of the spine showed that in the left lateral

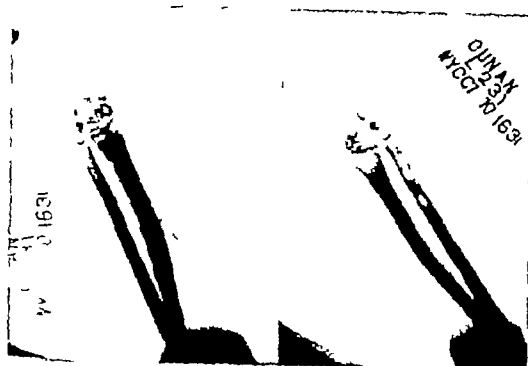


Fig 3 Case 2 Numerous punched out rarefied areas in bones of the forearms



Fig 4 Case 3 Irregular rarefied lesions in the femora, tibiae and fibulae



Fig 5 Case 3 Irregular rarefied lesions in the bones of the forearms

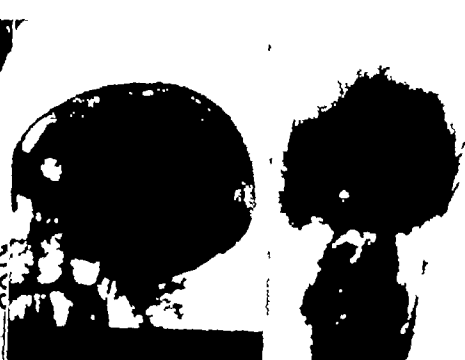


Fig 6 Case 3 Large rarefied areas in frontal part of the skull

areas of rarefaction in the bones of the forearms, the humeri, and the skull

On Nov 4, 1931, the pelvic pathology showed an increase in size and there was also some evidence of pathology in the upper end of the right femur

On Nov 11, 1931, the patient experienced a recurrence of the bleeding. A large area of ulceration was seen on the outer wall of the right nasal fossa, particularly involving the middle turbinate. This area was covered with a greenish gray mucopurulent slough.

On Dec 2, 1931, the patient had increased pain in the lower part of the left tibia, and bleeding from the nose continued. Numerous urine examinations were negative for Bence-Jones protein. Numerous blood counts were taken, but they were not significant.

In December more therapy was begun to the same areas treated before (the legs, sternum, and right hand), but was stopped at 400 r units because of the patient's transfer to Bellevue Hospital.

On Dec 28, 1931, the patient was bleeding profusely from the nose. After packing, he was sent to Bellevue Hospital for transfusion and further treatment.

Comment—This case is atypical in that its onset was marked with nasal bleeding three years prior to the objective bony changes and the beginning of pain. This man persisted in his work as traffic policeman until the recurrence of nasal bleeding forced him off duty.

Case 3 A S, No 7,400, butcher, age 40, was admitted Feb 3, 1931. Six months before admission the man began to limp and to have pain in the left ankle.



Fig 11 Case 5 Irregular destruction in the right side of the sacrum and ilium from crest to acetabulum



Fig 12 Case 6 Great enlargement of the sternum below the angle of Ludwig in anteroposterior diameter by an osteoid spongy material

the bone involvement was not present originally and that it gradually increased

Case 5 G R, No 8,788, male, age 57, was admitted to the New York City Cancer Institute on Jan 1, 1932. One year previous to admission he had received an injury to the right chest and he had since suffered from continuous pain there. No cough or expectoration, appetite poor. Since receiving high voltage treatment at Memorial Hospital during the previous four months, he has vomited three times a day. He also received twelve injections of Coley's serum. The pain in the right chest is worse when he stands up and also when he tries to work (dishwasher by occupation). Had biopsy in the right frontal area four months ago. Rest of history irrelevant.

Physical Examination—Patient is an anemic Greek, twenty years in U S A, speaks English imperfectly, appears to be normal mentally. Eyes pupils equal and react to light and accommodation. Ears, nose no discharge. Teeth pyorrhea alveolaris and bleeding from gums. Mucous membrane looks healthy. Thyroid not palpable. Chest resonant, with vesicular type of breathing, few râles at right base posteriorly, no adenopathy, rest of examination negative. On Feb 12, 1932, the temperature was 106° F, on Feb 13, 1932, he still had

high temperature, pulse dicrotic, general condition very poor. On Feb 14, 1932, the patient died.

On Feb 6, 1932, the Wassermann had been negative. On Feb 3, 1932, x-ray examination of chest, skeleton, skull, and long bones was as follows (Fig 9). There was an irregular extensive intercommunicating destructive involvement observed in the skull, chiefly in the frontal parietal at the vertex and also present in the occipital area. The margins of the lesion were well defined in the occipital region, especially appearing isolated in character. The lesions varied in size from a pinpoint to the largest aggregation in the frontal area measuring 9 X 6 cm in extent. There was curvature of the cervical spine, with convexity to the left in the upper thoracic region, and a distinct vertical compression in the body of the ninth thoracic vertebra. Bodies of the lower thoracic vertebrae were somewhat diffusely increased in density in the posterior projection. The lateral view showed an irregularly diminished density in the bodies of the vertebrae and an irregularity of the cancellous tissue arrangement. Pelvis (Fig 11). An irregular destruction was present involving the right side of the sacrum and ilium from the crest down to the acetabular rim. Irregular punched-out areas and rarefaction were made out in the left humerus, radius, and



Fig 7 Case 4 Extensive multilocular rarefaction of pelvic bones and femora



Fig 8 Case 4 Irregular rarefaction and diminished intervertebral disc space between the tenth eleventh and twelfth thoracic vertebrae, with upward and forward angulation of the twelfth thoracic vertebra



Fig 9 Case 5 Irregular extensive intercommunicating, destructive lesions in the skull at the vertex, varying in size



Fig 10 Case 5 Irregular rarefaction, with swelling in the right first, fourth, seventh and tenth ribs, and also in the left second and sixth ribs

portion of the bodies of the tenth, eleventh, and twelfth thoracic vertebrae there appeared an irregular rarefaction, with apparent haziness and diminished intervertebral disc space between the eleventh and twelfth thoracic vertebrae. This coincided with apparent angulation of the twelfth thoracic vertebra upward and forward. The lumbar spine did not show any definite changes. The upper portions of the sacrum revealed a diffuse irregular rarefaction similar to that in the pelvis. In the posterior view there was an irregular rarefactive involvement of the portion of the ribs visualized, most marked in the left tenth, eleventh, and twelfth ribs. The skull showed small irregular rarefactive lesions throughout, most pronounced in the upper parietal region. At this time the involvement of the scapulae and upper ends of the humeri seemed more pronounced. The bones of the forearms did not show any changes since the last examination. The Wassermann was negative.

On admission, the urine was cloudy, specific gravity 1.024, acid, 2 plus albumin. On March 28, 1931, the blood count had been hemoglobin, 85 per cent, white blood cells, 7,500. X-ray treatment (1,000 r) was given over the right hip and right lumbar spine from Oct. 29, 1931, to Nov. 9, 1931, over lower thoracic area, both shoulders, right and left lateral skull, and left wrist (6,000 r), from Nov. 24, 1931, to March 4, 1932, over lower thoracic region (600 r, incomplete), from March 28, 1932, to April 1, 1932. The patient has failed to return for follow-up study and treatment.

Comment—Although biopsy was not obtained, yet the course of the symptoms following the onset coincide with the cases of Simmond and Versé quoted by Kahn in which the trauma preceded the condition. In this case a comparison of our findings with the negative records from the hospital where the patient was confined for three months prior to admission to our Institute, shows conclusively that

mass is present over the mid-sternal region, extending into both breasts in the upper inner quadrants, which is divided

creased in density around the left fibula, upper part, the lateral margin of this area being irregular. These findings indicate



Fig 13 Case 7 Isolated rarefied areas in pelvis and femora



Fig 14 Case 7 Isolated rarefied areas in humeri

by an indentation in the midline. It is firmly fixed to the subjacent tissues and extends in a diffuse mass into the epigastric region. The liver is enlarged, the rest of the abdomen is negative. A soft tissue mass is felt in the upper lateral aspect of the left leg, firmly fixed to the bony tissues.

X-ray examination (Sept 15, 1932) of the chest showed the following: There is greatly increased density in, and increased width of, both hilus areas. There are extensive tuberculous lesions of the fibrotic and productive types in the upper lobes of both lungs. The cardiac shadow appears to be greatly enlarged in the transverse diameter. Several rounded shadows appear in the superior mediastinum (Fig 12). *Sternum*: The body of the sternum is greatly thickened in the anteroposterior diameter, the thickened region being filled in with an osteoid material which extends irregularly downward into the upper abdominal wall region. There is loss in identity between the cortical and medullary regions in the lower part of the sternum. *Left leg*: The soft tissues are in-

malignant manifestations in the mediastinum, which, in view of the unusual sternal and left leg pathology, suggest lymphosarcoma.

The Wassermann test was negative. Blood count was as follows: hemoglobin, 65 per cent, red blood cells, 3,240,000, white blood cells, 5,000. Urine showed albumin 3+, specific gravity, 1.003, red blood, epithelial, and pus cells, Bence-Jones protein absent.

Comment—This case illustrates the difficulty of differential diagnosis. Roentgenologically the isolated sternal lesion suggested lymphosarcoma, but the microscopic slide demonstrated myeloma, and the soft tissue leg tumor may have been merely a coincidence. We hope to report a biopsy from the leg at a later date.

Case 7 C F, No 9,717, housewife, age 52, was admitted to the New York City Cancer Institute, Sept 26, 1932. She was referred here for post-operative treatment two weeks following a mastectomy for malignancy. Prior to the mastectomy she had noted a slight redness of the right breast, with a lump in it and some swelling

ulna Ribs (Fig 10) An irregular rarefaction of similar localized type was visualized in the chondral end of the right first rib. A large bulging was seen in the posterior central portion of the right seventh rib, with irregular rarefaction in its center. An irregular destructive involvement of similar rarefactive type, with a breaking of the capsule, was observed in the anterior axillary portion of the right fourth rib. A similar moderately large area of rarefaction appeared in the posterior axillary portion of the right tenth rib. In the left side of the central posterior portion of the sixth rib there appeared a similar large bulging, with loss of calcium substance. This was also observed in the anterior condylar portion of the left second rib. The rest of the ribs showed diffuse change in density, with a small area of rarefaction. The lungs were clear. There were extensive multiple foci of multiple myeloma. The urine showed an occasional red blood cell but was otherwise negative. The blood count on Feb 2, 1932, was as follows: hemoglobin, 65 per cent, red blood cells, 2,900,000, white blood cells, 2,500.

Biopsy at Memorial Hospital showed tissue from skull, myeloma, cells not typical, but approach the plasma-cell structure, much foreign body reaction due to bone absorption.

Autopsy—Head Irregularity noted in left frontal region. *Heart* Aorta shows atheromatous changes. *Lungs* free, both upper lobes and left lower lobe well aerated. *Right middle and lower lobes* show some congestion, with areas of patchy consolidation and grayish discoloration. *Chest* Several ribs show localized swelling in different locations—the left second rib in the anterior portion, the fourth right rib in the antero-axillary line, the seventh right rib in the posterior portion, etc. *Spleen* Rather fibrotic and small. *Gall bladder* Contains stones, ducts are patent, rest of the tissues are normal. *Pathologic diagnosis* multiple myeloma and lobular pneumonia. *Histologic diagnosis* Atypical plasma-cell myeloma of bone and lobu-

lar pneumonia. *Report from Memorial Hospital* (review of slides of autopsy by Dr F W Stewart) "Oil emulsion shows cells are atypical plasma cells. An absent Bence-Jones means nothing since fully one-third of the myelomas never show it or show it only occasionally. The old hyaline tissue appears to be degenerated, osteoid bone surrounded by large foreign body giant cells. I don't know whether this is spontaneous or whether it followed radiation, with disappearance of tumor locally and the formation of atypical abortive callus. So far as I can see from the whole evidence at hand myeloma is the best we can do."

Comment—This case demonstrates the typical clinical course, with onset following injury, and rapid termination by pneumonia and proven by biopsy and autopsy. In this case x-ray treatment was of no avail in stemming the condition.

Case 6 P B, No 9,655, housewife, age 48, was admitted to the New York City Cancer Institute, Sept 14, 1932. The chief complaint was pain in the chest and cough of a year and a half duration. The pain began in the front and lateral regions of the chest. Shortly after the patient began to cough, especially at night, but this stopped after a while. One year ago the patient noticed a mass appearing in the mid-sternal region. A biopsy was performed at the Brooklyn Jewish Hospital and the slide was borrowed from there and diagnosed as myeloma by Dr Douglas Symmers, Director of the Division of Pathology in the Department of Hospitals of New York City. *Menstrual history* Two years ago there was profuse vaginal bleeding, gradually diminishing in amount each month, until at present she has only an occasional period, with small amounts of bleeding. There have been present hot flashes and other symptoms of the climacteric. The rest of the history is irrelevant. Physical examination showed bilateral exophthalmos, more marked on the right side, with bilateral palpebral ptosis. The patient complains of a sense of induration in the neck anteriorly. *Chest* A large

THE CLINICAL VALUE OF PUNCTURE BIOPSIES

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THIS analysis of 68 puncture biopsies is made in an attempt to evaluate the importance of the procedure, its efficiency, advantages, and limitations

The use of a needle and syringe for aspirating tumor cells in an attempt to simplify biopsy methods and minimize surgical trauma to the tumor is an old proce-

has obviated in considerable measure the tumor-disseminating incisional biopsy. It has permitted the microscopic study of deep-seated tumors which would otherwise have been treated blindly without histologic diagnosis

Despite increased proficiency developed by ample experience, several disadvan-

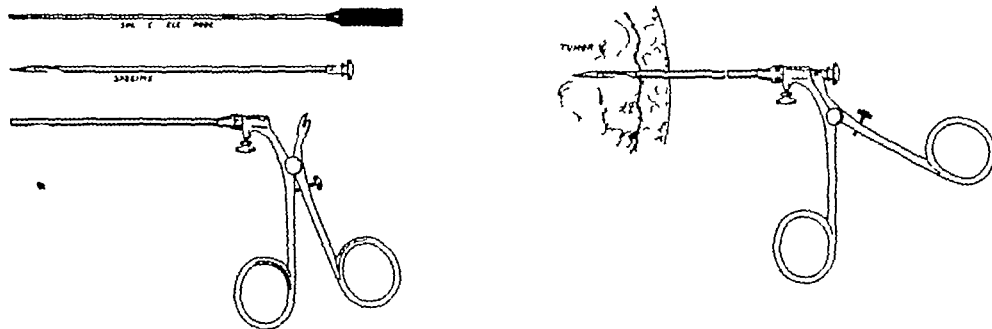


Fig 1 Diagram of Hoffman biopsy punch

cedure which has been popularized and expanded by Martin and Ellis (1) since 1930. Prior to that time, puncture biopsies, with or without suction, had been recommended in specific instances such as brain tumors and large nodes of malignant lymphomas. Martin and Ellis applied aspiration to various tumors with encouraging success, and found no danger of dissemination, for, as they said, "The danger of local or general dissemination through the minute break in the tumor capsule produced by an 18-gauge needle is comparatively slight."

The perfection of puncture biopsy procedures is a progressive step in tumor diagnosis, and has assisted materially in many instances in the selection of proper therapeutic measures. The use of them

tages became apparent in the aspiration method of biopsy (1). It was commonly necessary to puncture the tumor from two to twelve times before a few small bits of tissue were extracted, despite the fact that the technic outlined by Martin and Ellis, and later by Ferguson (2), was carefully followed, (2) the percentage of failures was high, particularly in hard, cartilaginous or fibrous tumors, (3) in several instances, these repeated punctures caused hemorrhages into the tissue and unquestionably stimulated the tumor to greater activity, (4) the bits of tissue which were obtained by aspiration were so small that they permitted only a direct smear without adequate fixation or sectioning of the specimen. This specimen usually stained poorly and provided indistinct cell detail

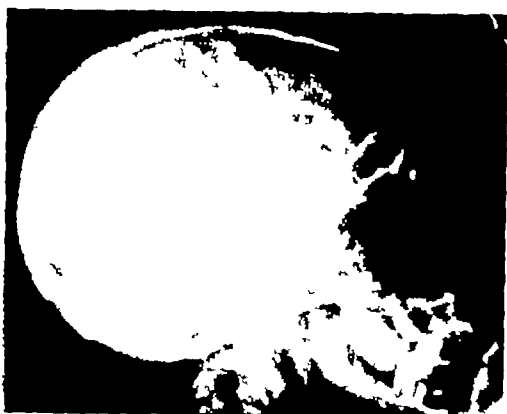


Fig 15 Case 7 Isolated rarefied areas in skull

of the right upper extremity no other symptoms Physical examination showed a right mastectomy scar and an induration in the whole right mammary region, the right axilla, both clavicular areas, and the posterior right shoulder The tissues of the right chest and axilla were fixed to the subjacent structures No axillary nodes were palpated The rest of the physical examination was negative

X-ray examination (Sept 27, 1932) showed (Figs 13, 14, and 15) a basal pleurisy in the right chest, areas of destruction in the ribs, with pathologic fractures in the right third and seventh ribs posteriorly, and the left fifth rib posteriorly, and localized rarefied areas throughout the skull, iliac bones, femora, humeri, radii, ulnæ, tibiæ, and fibulæ There was also a compression of the intervertebral disc space between the ninth and tenth thoracic vertebræ and a destructive process in the second lumbar vertebra

The Wassermann and urine tests were negative *Blood count* Hemoglobin, 85

per cent, red blood cells, 4,600,000, white blood cells, 13,000

High voltage x-ray therapy was administered to the right chest anteriorly and posteriorly and also to the right supra-clavicular area (3,000 r)

Comment—This case clinically has all the earmarks of a post-operative case of cancer of the breast, but the bone lesions roentgenologically assume more the typical appearance of multiple myeloma than of metastatic foci

CONCLUSIONS

1 Multiple myeloma is still sufficiently rare, although the x-ray has quickened the impetus of diagnosis

2 Multiple myeloma is insidious in onset, vague in symptomatology, and lacking in physical findings, rendering the x-ray of primary importance in the clinical diagnosis

3 Differential diagnosis from other similar bone changes is at times very difficult

4 Trauma may play a rôle in its onset

5 X-ray treatment aids the clinical symptom of bone pain, when present, and may temporarily retard the progressive bone destruction

6 Prognosis is still very poor

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pointed to discover that the piece of tissue removed consists of strands of fibrous tissue or overlying muscle

2 *Traumatic Aggravation of the Tumor*—We have seen several instances in

Hoffman biopsy punch finds its greatest field of usefulness (see Fig 2) Because the roentgen evidence is so frequently inconclusive, the diagnosis of a bone tumor is often in doubt These tumors vary so

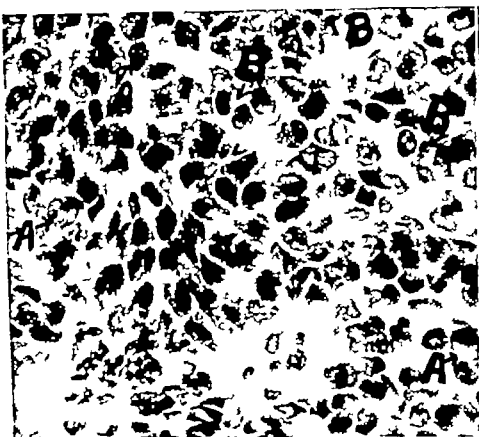


Fig 2 Case 4 Chondroblastic osteogenic sarcoma of the sacro iliac joint (A) Large somewhat indistinct nuclei of the young chondroblast, in the stage before the formation of the hyaline matrix (B) The more adult, though not yet fully formed multinucleated cartilage cell with the hyaline matrix This is the only radiosensitive type of osteogenic sarcoma and an exact diagnosis is necessary for proper treatment

Fig 3 Case 2 Endothelial myeloma of scapula Characteristic small, polyhedral cells with round and oval nuclei Diagnosis confirmed by rapid response of tumor to radiation

which the injury inflicted by the examining needle has produced an immediate swelling of the tumor due to hemorrhage or to rupture of a capsule which has been under tension This swelling subsided partially and then enlarged more rapidly than before Doubtless, in these instances the diagnostic needle produced definite injury These injuries, however, are by no means as severe and dangerous as those produced during the course of a surgical biopsy

3 *Significance of a Negative Puncture Biopsy*—A negative puncture biopsy has little significance The failure to obtain malignant tissue by either method does not rule out its presence Where the clinical setting suggests malignancy, the biopsy should be repeated

BONE TUMORS

In the diagnosis of bone tumors, the

widely in their clinical course, prognosis, and radiosensitivity, and their treatment may require either the sacrifice of a limb or the relatively simple procedure of curettage and chemical cautery, or irradiation, that a positive diagnosis is absolutely essential In a group of 17 bone tumors in which punch biopsy was attempted, only once did the instrument fail to provide tissue for diagnosis This so-called failure was due to the fact that the tumor was a central giant-cell tumor of the ischium, surrounded by a solid bony shell which could not be penetrated by the instrument As a matter of fact, this difficulty should have been anticipated from the roentgenogram, and the punch biopsy never attempted Another bone lesion which may yield an unsatisfactory biopsy specimen is sclerosing osteogenic sarcoma In this type of tumor, in which there is little or no erosion of the cortex,

and tissue structure so that one could determine only the presence or absence of malignancy in the majority of cases. Often it was impossible to make a decision as to the character of the cells obtained, so that the total information provided by the procedure was greatly limited. These smears of disorganized cells required special experience on the part of the pathologist if falsely positive diagnoses were to be avoided or a high degree of diagnostic accuracy maintained.

In January, 1931, Hoffman (3, 4) described his invention of a special biopsy punch. This instrument (Fig 1) was larger than the 18-gauge aspirating needle, and was made in two sizes 2 mm and 3 mm in diameter. However, this defect of larger size was compensated for by the fact that only a single puncture was necessary to obtain a piece of tissue at each attempt. Furthermore, the specimen removed was always large enough to permit not only the making of a direct smear, but also of a paraffin section. Thus, cell detail and tissue architecture, which are so

important in diagnosing and classifying malignant tumors, were preserved, and no special skill or training on the part of the pathologist was required in the interpretation.

For these reasons, the aspirating needle was discarded in favor of the Hoffman punch. The biopsies reported in this series have all been taken with the latter instrument.

DISADVANTAGES OF ALL METHODS OF PUNCTURE BIOPSY

1 *The Nature of the Tumor*—Large nodes containing metastatic squamous carcinoma are prone to undergo necrosis or secondary infection. The puncturing needle thus obtains a semi-fluid material composed of liquefied, degenerated cells, or cells obscured by inflammatory transudate which may reveal no definite evidence of malignancy under the microscope. In the case of small nodes, it is very difficult to place the point of the needle or punch within the node in such a way as to obtain tumor cells, and one is often disap-

COMPARISON OF ASPIRATION BIOPSY WITH HOFFMAN PUNCH BIOPSY

Aspirating Needle

Its small diameter (18 gauge), 1 mm, causes little trauma during a single introduction but the total trauma of multiple punctures may be considerable.

Obtains only a few minute fragments of tissue or clumps of cells which permit only a direct smear rarely, a paraffin section.

Can be used safely in the vicinity of important structures such as the carotid arteries, vagus nerve, or in the lung, liver, or spleen.

Cannot be depended upon to obtain a specimen from the wall of a cyst.

Smear often fails to reveal good cell detail. Tissue architecture usually impossible to recognize.

Special experience on the part of the pathologist required to interpret the smears.

Information obtained from smear usually limited to a diagnosis of malignancy or benignancy although tumors composed of special cell types may be recognized on smear (giant-cell tumors, squamous carcinoma, etc.).

Diagnostic efficiency is lower than with the biopsy punch particularly in firm, fibrous or cartilaginous tumors.

Falsely positive diagnoses occasionally are made.

Hoffman Biopsy Punch

Larger diameter (2 mm and 3 mm) produces more trauma during its introduction but usually, only a single puncture is required.

A larger, solid piece of unchanged tissue is obtained sufficient to permit the making of a smear and a paraffin section in every case.

Must be used with caution in the vicinity of important structures. Should not be employed in the thorax or abdomen.

Specimen easily obtained from the wall of a cyst.

Paraffin section provides excellent cell detail and tissue architecture.

No special experience necessary to diagnose the paraffin sections of a punch biopsy.

Accurate diagnosis and pathologic classification of tumor usually easy.

Diagnostic efficiency high in all types of tumor into which the instrument is introduced.

No falsely positive diagnoses.

introduce the instrument into the affected area

METASTATIC TUMORS OF BONE

This is a miscellaneous group of bone

of some (Fig 4) In situations of this kind, the positive diagnosis of metastatic carcinoma provided by the punch biopsy may preserve the patient from a futile and mutilating amputation



Fig 4 Case 19 Metastasizing papillary adenoma of the thyroid gland Puncture biopsy taken from mass in the right ilium Roentgenographic diagnosis was malignant cystic tumor of bone The calcified fibroids were incidental Normal appearing flat columnar cells (A) lining the alveoli, and acini filled with colloid (C) are characteristically benign The cellularity of the stroma (B) is only faintly suggestive of malignancy



Fig 5 Case 23 Papillary adenocarcinoma of the fundus uteri metastasizing to the ischium Mass in ischium was the first clinical sign, and resembled roentgenographically a giant-cell tumor Needle punch biopsy revealed (P) papillary stalks consisting of solid and cystic masses of cells mounted on a ramifying connective tissue base (S) Numerous areas of alveolus formation (C)

tumors Some of them were originally considered primary tumors of bone, and some were thought to be metastatic tumors of undetermined origin In seven out of eight cases the punch biopsy revealed not only the true nature of the tumor, but also the probable source of origin

Case 23 (Fig 5), an adenocarcinoma of the fundus uteri, first manifested itself as an osteolytic process of the ischium A punch biopsy of this tumor revealed a papillary adenocarcinoma, whose source was thought to have been the uterus or ovary Though there were no symptoms

it may be found impossible to introduce the punch, and consequently the specimen of tissue obtained may reveal only newly formed reactive bone containing no malignant cells. Cases 8 and 13 were ex-

Occasionally it is impossible to make an exact histologic diagnosis of a very cellular malignant bone tumor, and one must rely upon the response to radiation therapy to differentiate between a cellular osteo-

TABLE I—BONE TUMORS

No	Clinical Diagnosis	Location	Histology	Result of Biopsy
1	Osteogenic sarcoma	Upper humerus	Chondromyxosarcoma	+
2	Osteogenic sarcoma	Acromial process	Endothelial myeloma	+
3	Fibrocystic disease	Ilium	Chondroma	+
4	Sarcoma	Sacro-iliac joint	Chondroblastic osteogenic sarcoma	+
5	Giant-cell tumor	Ischium		-
6	Osteomyelitis	Astragalus	Inflammatory tissue	+
7	Malignant bone tumor	Ilium	Cellular, undifferentiated malignant tumor	+
8	Malignant tumor in bone	Sacrum	Fibrous connective tissue	-
9	Osteogenic sarcoma	Femur	Fibrous inflammatory tissue	+
10	Chondroma	Pubis	Cartilage cells	+
12	Fibrocystic disease	Mandible	Fibrous tissue	+
13	Osteogenic sarcoma	Upper femur	Fibrous tissue and possibly bone cells	-
14	Osteogenic sarcoma	Sacrum	Cellular malignant tumor	+
15	Cyst of mandible	Mandible	Chronic inflammatory tissue	+
16	Osteogenic sarcoma	Lower femur	Malignant cellular tissue with incomplete cartilage and bone formation	+
17	Osteogenic sarcoma	Pubis	Endothelial myeloma	+

Fourteen positive results out of 17 (82 per cent)

TABLE II—METASTATIC CARCINOMA OF BONE

No	Clinical Diagnosis	Location	Histology	Result of Biopsy
18	Primary or metastatic tumor	Ilium	Metastatic carcinoma	+
19	Metastatic carcinoma of thyroid	Ilium	Papillary adenoma of thyroid	+
20	Tumor	Sacro-iliac region	Transitional cell epithelioma	+
21	Generalized malignancy	Mandible		-
22	Metastatic carcinoma of thyroid	Rib	Anaplastic carcinoma	+
23	Metastatic carcinoma	Ischium	Papillary adenocarcinoma (uterus or ovary)	+
24	Osteogenic sarcoma	First rib	Metastatic epithelioma	+
25	Carcinoma of cervix with bone metastasis	Sacrum	Plexiform epithelioma	+

Seven positive results out of eight biopsies (87 per cent)

amples of this, and failed to reveal abnormal tissue

In this group of bone tumors, there were 14 positive results out of 17 attempts (81 per cent). In Case 6, the diagnosis rested between osteogenic sarcoma and osteomyelitis. The punch biopsy revealed inflammatory tissue. The diagnosis was confirmed at a subsequent operation

lytic osteogenic sarcoma and an endothelial myeloma (Case 2) (See Fig 3)

It is difficult to obtain tissue from a cystic tumor of the mandible because of the usual surrounding impenetrable bony shell, or because the tough masseter muscle deludes one into mistaking it for tumor tissue, and the operator therefore fails to in-

Punch biopsies of breast tumors are indicated in advanced, inoperable carcinomas, in cases in which final confirmation is desired for corroboration of the clinical diagnosis, and for an estimation of the radio-sensitivity of the tumor as a guide in determining the type of radiotherapy most desirable.

Following radical mastectomy, it is often difficult to differentiate between a local recurrence and a muscle stump. Punch biopsy in these cases constitutes a valuable aid.

In a primary breast carcinoma, should the punch biopsy fail to reveal any evidence of cancer, and the clinical setting not be clearly characteristic of a benign tumor, one should not assume the absence of cancer but promptly perform a surgical biopsy. Cases 30, 31, and 32 illustrate this point. The punch biopsies were negative, but frozen section examinations revealed the presence of cancer.

Repeated punch biopsies, or multiple punctures to obtain numerous specimens from different areas are contra-indicated in vascular or rapidly growing breast tumors. The excessive trauma in two of the above cases was followed by enlargement of the tumor.

Of the 14 primary and recurrent breast tumors in this series, 11 punch biopsies (78 per cent) yielded positive diagnoses.

CERVICAL NODES

In the group of cervical lymph node enlargements, punch biopsies registered the largest percentage of failures. This was due to many reasons. Frequently the nodes were small, and the punch obtained either a part of the capsule or the overlying muscle. The proximity of so many vital structures deterred the operator from inserting the needle deeply enough in some instances. Many of the larger nodes had undergone central necrosis, and examination of this material revealed the shadowy outlines of cells suspiciously resembling carcinoma but not definitely diagnostic. These failures in diagnosis are attributable

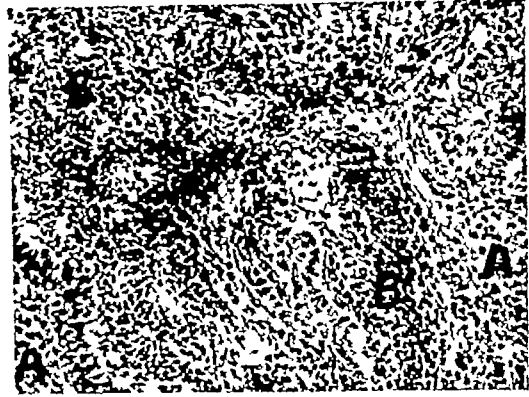


Fig 6 Case 42 Metastasizing basal cell epithelioma. Primary lesion was a rodent ulcer of the temple about 2 cm in diameter. The above photomicrograph is that of the needle punch biopsy taken from the enlarged submaxillary node on the same side. (A) Characteristic basal arrangement of the carcinoma cells. (B) Stroma with considerable lymphocytic infiltration.

to the character of the material rather than the instrument used. Because of the reluctance to diagnose cancer on such degenerated material, and because of the probability of missing a small malignant deposit in a node, the value of a negative biopsy here is questionable.

The microscopic diagnosis of Hodgkin's disease is difficult to make under the best of conditions. It is usually necessary to examine large areas of tissue before finding characteristic cells or architecture. While the biopsy punch always obtains tissue, the amount is frequently insufficient to exhibit all the cellular elements, such as Dorothy Reed cells, reticular hyperplasia, and eosinophilic cells, which form the basis of the histologic diagnosis of Hodgkin's disease. In the presence of multiple small cervical or general lymphadenopathy, it is wiser to excise a whole node for microscopic examination.

In this group of 14 cases, there were five failures (64 per cent positive results) (Fig 6). Two of these failures exhibited groups of cells which, though suggestive, could not positively be identified as malignant cells.

referable to the pelvis, a gynecologic examination was made and the uterus found to be slightly enlarged. A curettage showed the presence of papillary adenocarcinoma of the fundus on subsequent his-

amination of the piece of tissue removed while the patient is on the operating table. A certain group of patients, however, will refuse to permit an operative biopsy in a tumor whose clinical appear-

TABLE III —TUMORS OF THE BREAST

No	Clinical Diagnosis	Location	Histology	Result of Biopsy
26	Primary operable carcinoma of breast	Breast	Anaplastic carcinoma	+
27	Primary inoperable carcinoma	Breast	Medullary carcinoma	+
28	Primary advanced carcinoma	Breast	Medullary carcinoma	+
29	Primary inoperable carcinoma	Breast	Anaplastic carcinoma	+
30	Primary operable carcinoma	Breast	No malignancy	-
31	Primary operable carcinoma	Breast	No malignancy	-
32	Primary operable carcinoma	Breast	No malignancy	-
33	Primary operable carcinoma	Breast	Fibroadenoma	+
34	Chronic mastitis	Breast	Compressed normal glands	+
35	Lipoma	Breast	Fatty tissue	+
36	Recurrent carcinoma of breast	Chest wall	Medullary carcinoma	+
37	Recurrent carcinoma of breast	Supraclavicular node	Metastatic carcinoma	+
38	Recurrent carcinoma of breast	Chest wall	Medullary carcinoma	+
39	Recurrent carcinoma of breast	Chest wall	Small group of malignant cells	+

Eleven positive results out of fourteen attempts (78 per cent)

TABLE IV —CERVICAL NODES

No	Clinical Diagnosis	Location	Histology	Result of Biopsy
40	Malignant lymphoma	Upper neck	Normal salivary gland	-
41	Neck node undetermined origin	Lower neck	Cellular fibrous tissue	-
42	Metastatic basal cell carcinoma of skin	Posterior neck	Metastatic basal-cell carcinoma	+
43	Tuberculous neck nodes	Hyoid node	Myositis	-
44	Benign neck node	Angle of jaw	Benign chronic lymphoma	+
45	Metastatic carcinoma of lung	Lower triangle of neck	Metastatic bronchogenic carcinoma	+
46	Neck node undetermined origin	Lower neck	Fibrous tissue	+
47	Metastatic carcinoma from mouth	Lower neck	Few suspicious malignant cells	+
48	Carcinoma of larynx	Posterior triangle	Squamous-cell epithelioma	+
49	Carcinoma of lung	Supraclavicular triangle		-
50	Carcinoma of lung	Lower neck	Metastatic epithelioma	±
51	Neck node undetermined origin	Lower neck	Epidermoid carcinoma Grade 3	±
52	Malignant lymphoma	Angle of jaw	Simple lymph node	-
53	Mediastinal tumor	Lower neck	Anaplastic carcinoma	±

Nine positive results out of fourteen attempts (64 per cent)

tologic examination. In another instance, Case 24, a tumor diagnosed as a primary osteolytic osteogenic sarcoma of the first rib was shown to be a deposit of metastatic carcinoma.

TUMORS OF THE BREAST

In tumors of the breast, punch biopsy should not replace the frozen section ex-

amination is not alarming, and will insist upon delay until the tumor has given unmistakable evidence of its malignant character. These patients usually will not refuse to permit a punch biopsy which can be performed in the physician's office at the time of the first examination. Thus the most important and dangerous element in the treatment of cancer, namely, delay, is eliminated.

PREPARATION OF THE SPECIMEN

Care in the handling of the specimen so

4 Punch biopsy, however, should not replace the formal surgical biopsy of tumors of the breast made in the operating

TABLE V — MISCELLANEOUS TUMORS

No	Clinical Diagnosis	Location	Histology	Result of Biopsy
54	Fibrosarcoma of leg	Calf of leg	Mixed spindle- and giant-cell sarcoma	+
55	Fibrosarcoma of thigh	Mid thigh	Fibromyxosarcoma	+
56	Fibrosarcoma of thigh	Mid thigh	Spindle-cell sarcoma	+
57	Adenoma of thyroid	Thyroid gland	Indistinct glandular tissue	+
58	Recurrent tumor of thyroid	Thyroid gland	Anaplastic carcinoma	+
59	Malignant lymphoma	Axillary node	Lymphosarcoma	+
60	Metastatic perithelioma	Shoulder	Perithelioma	+
61	Lung tumor	Lung	Cellular fibrous tissue	-
62	Benign tumor	Pre parotid area	Muscle tissue	-
63	Possible carcinoma of prostate	Prostate	Normal prostate	+
64	Possible carcinoma of prostate	Prostate	Normal prostate	+
65	Carcinoma of lung	Lung	Normal lung tissue	+
66	Cervical adenitis	Neck node	Parotid tumor	+
67	Lymphosarcoma	Skin nodule	Lymphosarcoma	+
68	Lymphatic leukemia	Inguinal node	Lymph node with sinuses filled with lymphocytes	+

Thirteen positive results out of fifteen attempts (86 per cent)

as not to lose the cellular portion attached to the tough fibrous stroma, and also the subsequent preparation of the microscopic slide are of paramount importance. Some of our earlier failures could be attributed to this omission, others to improper fixation and staining of the section.

We employ only paraffin sections which require forty-eight hours to complete. In urgent cases, these sections can be prepared in three hours. The immediate smear and staining method destroys tissue architecture so that the specific type of tumor can only occasionally be recognized.

CONCLUSIONS

1 Puncture biopsy is a valuable aid in providing a diagnosis of a suspected tumor. It may obviate an operative procedure with its severe traumatic dissemination of tumor cells.

2 The Hoffman biopsy punch and technic is superior to the aspirating needle.

3 This biopsy punch is particularly valuable in the diagnosis of tumors of the breast and bones. It has a high percentage of diagnostic efficiency in tumors of all types and consistencies.

room with preparation for a radical mastectomy if the specimen proves to be malignant. In those cases in which the patient will not permit a surgical biopsy the Hoffman punch affords an easy method of diagnosis which the average patient will accept.

5 In a case of suspected Hodgkin's disease the excision of a node is preferable to a punch biopsy in order to provide enough tissue for a careful and patient search for the diagnostic features of this disease.

6 In this series of 68 attempts, 54, or 80 per cent, of the punch biopsies were successful in providing correct histologic information. No false positive diagnoses were made.

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MISCELLANEOUS GROUP

biopsy provides valuable results. In this series, there were nine successful biopsies in fourteen attempts (64 per cent)

In this group, comprising tumors of the



Fig 7 Case 56 Spindle-cell fibrosarcoma of the thigh (S) Characteristic spindle cells with little stroma, adult in type (C) Capillaries, lined with adult endothelium. In spite of this adult picture, the tumor was moderately radiosensitive.

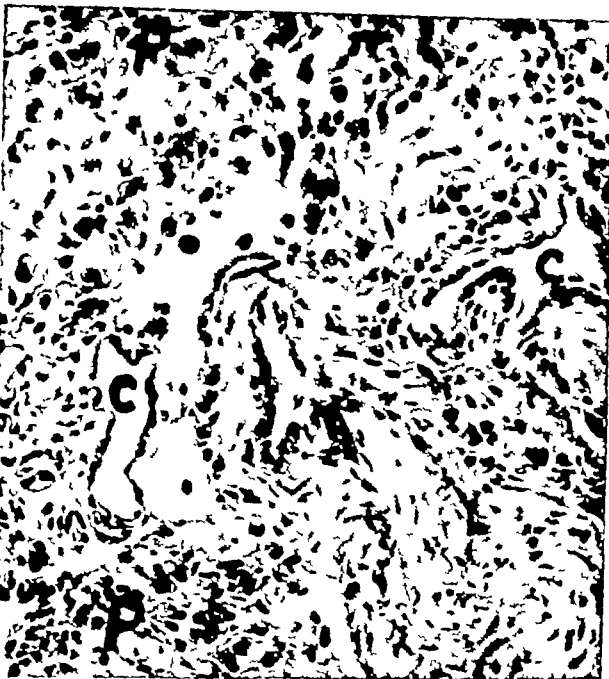


Fig 8 Case 60 Perithelioma of the skin of the leg. Punch biopsy taken from a metastatic nodule in the supraclavicular area (C) Capillaries (P) Large, acidophilic tumor cells.

thyroid and prostate glands, lymphosarcoma, sarcoma of the soft tissues, etc., the punch biopsy assisted remarkably in their diagnosis (Figs 7 and 8).

Tumors of the lung tempt one to use the biopsy punch, but the profusion of large vessels and bronchioles, which might easily be punctured, limits such a method to peripheral and apical new-growths. In this type of tumor, aspiration is safer and yields some positive results. In one of our cases (Case 61), we attempted a punch biopsy of a deep-seated lung tumor. The growth was missed, but a small piece of easily recognizable normal lung tissue was removed without complication. In sarcomas of muscle, fascia, and tendon sheaths, punch

ELECTROCOAGULATION

The Hoffman biopsy punch is provided with a coagulating electrode, which is inserted through the cannula after the tissue has been removed. By this means, the opening in the tumor and needle tract are coagulated in order to arrest any bleeding and prevent dissemination. The practical value of this part of the technic in preventing dissemination is difficult to estimate. As far as the control of bleeding is concerned, capillary oozing may be controlled by simple pressure, while profuse bleeding could never be controlled with this single electrode.

or diagnostic value—and the emulsions were preserved perfectly

In order to deal intelligently with the situation brought about by summer heat, it is necessary to understand something of the chemistry and physics involved. An x-ray film consists of a sheet of celluloid, coated on both sides with gelatin in which the sensitive salts are embedded. Development consists of the reduction to metallic silver of those salts which have been acted on by the rays, by means of the reducing action of the developing agents in alkaline solution. Fixation is the removal of the unreduced silver salts by the action of sodium thiosulphite (hypo), usually employed in acid solution. Washing is merely to remove the chemicals absorbed in the processing. Gelatin is a colloid and, when wet, absorbs water, swells, and becomes soft and spongy. This phenomenon takes place in degree and rapidity proportionate to the temperature, and inversely proportionate to the osmotic pressure (salt content) of the solution. At and below 65 degrees F, swelling of the gelatin is almost negligible, but for some reason, changing a film to a bath of higher or lower temperature seems to do much more damage than keeping the film at a higher temperature from the first. When the emulsion is in this boggy, swollen state, it is very easily stripped off by a chance contact with even a finger and occasionally slips on its celluloid mount of its own accord.

At first thought, the obvious answer to this problem is *ice*. Cooling of solutions is of untold value, but any one who has ever tried to work in an ice-packed tray will agree that it is far from ideal. For one thing, all the solutions, *including the wash water*, must be kept within a few degrees of the same temperature, or very little will have been accomplished. An electrically refrigerated tank system is, of course, infinitely more convenient and efficient but by no means perfect. Remember, the film has to be taken out to dry, and sometimes has to be taken out for emergency interpretation (the Num-

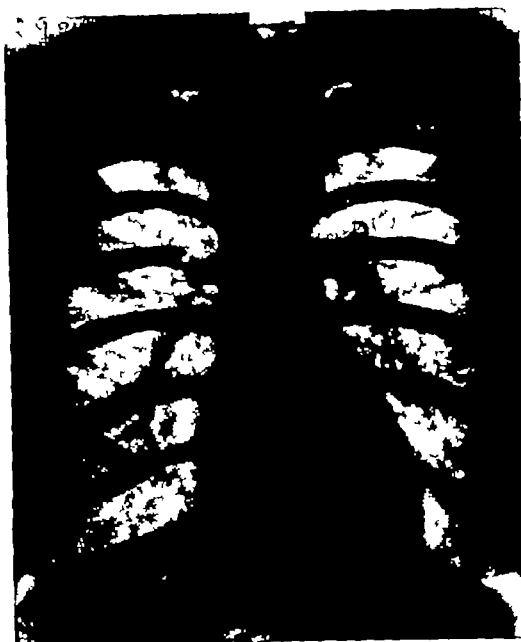


Fig 2 Film processed at 89 degrees F by the sulphate formalin method. Same patient, identical exposure with Figure 1

ber One enemy of a boggy emulsion), and as soon as the warm air strikes the surface coat of water, the gelatin swells and swells rapidly. Few laboratories have installed a refrigerated drying box. Drying before fans helps, and emersion in 95 per cent ethyl alcohol after washing speeds the drying and helps still more. Incidentally, removal of excess water by swabbing the washed film with the new "Viscose Sponge," obtainable from any photographic supply house, gives quicker and more even drying and will not damage the emulsion. But all of these extra steps and the added equipment take time and increase the operating expense to no small degree.

Fortunately, there is a much more practical and inexpensive salvation. Gelatin may be hardened or "tanned" quite easily. Formalin possesses unlimited power of hardening the emulsion, in fact, a film treated sufficiently with formalin may be subjected to boiling water without damage. The ideal would seem, then, to bathe the film in formalin as the first step

PROCESSING X-RAY FILMS AT HIGH TEMPERATURES

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THE processing of films in summer months and in tropical climates offers many difficult problems and often taxes almost to the limit the ingenuity as well as the nerves of the dark-room technician. There is scarcely an x-ray

pital dark room (and both types suffer from the heat). By the use of some very simple measures available to any one, it is not only possible but quite easy to finish x-ray films at temperatures up to 95 degrees F without any cooling of the solutions, yielding results comparable to any that could be obtained under ideal conditions.

The accompanying illustrations show what can be done at higher temperatures. Figures 1 and 2 are identical exposures of the same patient on Eastman safety film. Figure 1 was finished by our regular technician in refrigerated tanks at 65 degrees F with Eastman prepared chemicals. Figure 2 was finished by the sulphate-formalin process, to be outlined here, at room temperature of 89 degrees F. Figure 3 shows what normally happens when a film is processed in too warm solutions without some special procedure. I have been more or less seriously interested in photography for some twelve years and have tried many recommended means of combating heat, an even more serious problem to the photographer than to the radiologist. The method presented here has been used by me in photography for several summers, and much longer by countless other photographers, with excellent results. It has been tried in our laboratory here during the Summer of 1934 and found to be quite practical for x-ray purposes. We have run duplicate exposures, of which Figures 1 and 2 are examples, using one as a control by running it through the routine refrigerated tanks and processing the other at temperatures ranging from 70 degrees F to 95 degrees F. The films were then reviewed at our regular film-reading conferences. Those finished at higher temperatures were found not to be inferior to the controls in any respect—detail, contrast, etc.

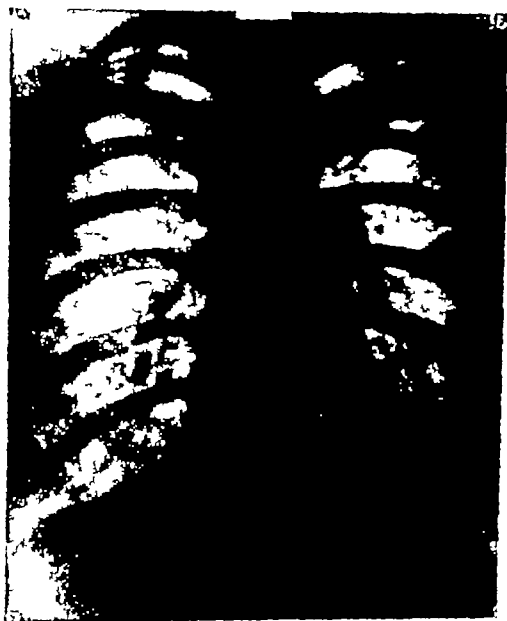


Fig 1 Control film, processed in refrigerated tanks at 65 degrees F with EKC prepared chemicals

laboratory that is not familiar with the peeled, scratched, crinkled emulsion peculiar to high temperatures. These obstacles offered by heat are all too often dismissed as insurmountable and wretchedly macerated emulsions accepted with a Job-like attitude. Photographers, especially those in Government service have found means of combating the effects of heat and with little trouble these measures can be applied to any x-ray processing room, whether it be a 4 X 4 foot closet in a private office or a large refrigerated hos-

added to the fixing bath if formalin is to be used with it. The function of the acidifier is merely to prevent the alkali carried over from the developer from causing yellow stains on the film, and it may be replaced satisfactorily by an acid bath before placing the film in the neutral fixing solution. Such an acid short stop may be prepared by dissolving 13 ounces of sodium sulphate in a gallon of water, and adding 12 ounces of 28 per cent acetic acid. The films should be bathed in this solution for about thirty seconds before fixation and after development. Rinse in water rapidly before and after, using the short stop.

A suitable formalin fixing bath is given in the following formula

	Avoirdupois	Metric
Sodium hyposulphite (hypo)	2 lb	960 gm
*Sodium sulphate, desiccated	6 oz	180 gm.
Formalin (commercial, 40%)	16 oz	500 c c
Water, q s ad	1 gallon	4000 c c

* If crystals are used, double the amount will be required. Dissolve the chemicals in the order given.

This combined fixing and hardening bath will keep in good condition for about two weeks. It is advisable to keep it well corked when not in use, as the formalin evaporates very rapidly.

If prepared fixing baths are preferred, simply discard the small container marked "acidifier" and dissolve the contents of the larger package in the specified amount of water to which is added the formalin, 16 ounces to the gallon of fixing bath.

Fix in one of the above baths for the normal time, about one and a half times the length of time required for the film to clear. By this time, the emulsion will be thoroughly hardened and with normal care the film may be handled without damage. Washing should be carried out as usual, in water as near the temperature of the processing solutions as is practical, although the temperature of the wash water is not so important after treatment with formalin. Dried in a dust-free room, the emulsion will be as smooth and the film as perfect as one processed under ideal conditions.

Where a refrigerated tank is used and

temperature can be maintained constantly at lower levels, the sodium sulphate developer is not necessary, because, at the ideal temperature of about 65 degrees F, very little swelling of the emulsion takes place. Indeed, it would be undesirable to add sulphate to a developer to be used at lower temperatures because of the tendency it possesses to prolong developer time, a very desirable feature at higher temperatures where the time would be otherwise too short. However, replacement of the usual acid fixing bath by the acid short stop and neutral formalin fixing baths mentioned above will eliminate most of the emulsion hazard of wet-plate reading, and drying in warm air.

SUMMARY

A few important points might be mentioned in conclusion.

It cannot be stressed enough that the vital point about temperature in processing is not that it be low, *but that it be constant*. All baths, including wash water, should be within a few degrees of the same temperature.

Sodium sulphate preserves the emulsion only so long as it is in contact with it, the action being purely a temporary physiochemical one.

Formalin, the perfect hardener, cannot be used before or during development on account of the tendency to produce chemical fog. It cannot be added to an acid fixing bath as it causes a heavy white precipitate.

When a neutral fixing bath is employed an acid short stop must be placed between the fixing bath and the developer or yellow stains will appear on the film. If they do occur, leave the film in the short stop longer, renew the short stop, or add more acetic acid.

Formalin evaporates, so, if proper hardening does not take place, add more formalin to the fixing bath or renew the entire bath.

Generalized brownish-yellow stains on the films may be caused by iron salts in



Fig 3 Showing the effects of heat on a film processed by usual methods at higher temperatures

in processing, but this causes so much chemical fog as to be impractical. And, by the time development has been completed at a temperature of 70 degrees F or above, the damage has been done and the coating too boggy to be "tanned." Something must be done at the very onset of immersion of the film in solution. If we are able to carry the emulsion through development without appreciable change, we may then use formalin without fear of fog.

As was pointed out above, swelling takes place inversely proportionate to the osmotic pressure of the solution. The addition of any salt in high concentration in the solution tends to inhibit this occurrence. Most salts influence the action of the developer or cause chemical fog, but there is one readily available compound, sodium sulphate, which does neither and is very effective in preventing swelling.

The following formula (Eastman D19a, plus sulphate) is quite satisfactory for hot weather use.

	Avoirdupois	Metric
Water, about 130 degrees F	2 quarts	2000 c.c.
Elon	128 grains	8.8 gm
*Sodium sulphite, desiccated	12 oz., 300 gr	300.0 gm
Hydroquinone	1 oz. 60 gr	34.4 gm
*Sodium carbonate, desiccated	6 oz.	180.0 gm
Sodium sulphate	13 oz.	390.0 gm
Potassium bromide	300 gr	20.0 gm
Cold water, q.s. ad	1 gallon	4000 c.c.

* If crystals are used, twice the amount will be required. Dissolve chemicals in the order given.

If one prefers to use prepared developer powders, all that is necessary is that 13 ounces of sodium sulphate be added to each gallon of the solution in its final dilution for use. No exact timetable can be given, but, for the above formula, development should be complete at

65 degrees F	in 9 minutes
75 degrees F	in 4 minutes
80 degrees F	in 3 minutes
85 degrees F	in 2 minutes
90 degrees F	in 1 1/2 minutes

This table of development time is fairly accurate for any developer that would normally develop a film in five minutes at 65 degrees F without the added sulphate. The sodium sulphate almost doubles the time required for development, with the average developer alone, the time of development at 85 degrees F, or above, would be inconveniently short. Development in a sodium sulphate developer leaves the emulsion in a comparatively unswollen state, as can be detected readily by rubbing the film with the fingers. Remember, however, that sodium sulphate protects the emulsion *only so long as it is in contact with the emulsion* and has nothing whatsoever to do with what happens to it later. Its action is purely to prevent swelling by raising the osmotic pressure of the developing solution, nothing more.

We now have our film developed, free from fog and damage to the emulsion. Formalin can now be used to tan the gelatin and insure it against future damage. Since the action of formalin requires several minutes, the most satisfactory method of employing it is to mix it in the hypo-fixing bath. An acidifier must not be

THE EFFECT OF ROENTGEN IRRADIATION OF THE ENTIRE ANIMAL ON THE PHOSPHATASE ACTIVITY AND ELECTROLYTE CONTENT OF ITS WATER EXTRACT¹

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It was found in a previous study (1) that exposure of growing dog bone to moderate doses of roentgen rays is followed by a period of lowered phosphatase activity beginning a few days after exposure and showing a tendency to return to normal after from three to five weeks. Since the enzyme phosphatase is so widely distributed in the animal body it was felt that a study of the phosphatase activity of the entire body after exposure to x-rays would be of interest. Also, we desired to determine the concentration of certain electrolytes, some of which are known to influence the activity of the enzyme. Loiseleur and Van der Schueren (2) and Adler and Wiederhold (3) have studied the metabolism of several inorganic substances in the rabbit following x-ray irradiation. Kinard and Chanutin (4) found that the phosphatase activity of the whole rat was increased following large doses of irradiated ergosterol.

Analytical Methods—The phosphatase determinations were made by a technique similar to that described by Jenner and Kay (5) for plasma phosphatase. Chlorides were estimated by the method of Van Slyke and Sendroy (6). The other inorganic substances were determined by methods adapted to this type of work by Cullen and Wilkins (7).

Procedure—Two litters of New Zealand white rabbits, 25 and 31 days of age, respectively, were used. Each litter was divided into two groups; one group of each was subjected to deep x-ray therapy (550 to 1,100 roentgens) over the entire body, the other group being used for controls. The factors constituting the dose of x-ray were 190 to 200 kilovolts, 20 milli-

amperes, 50 cm target-skin distance, filter of 0.25 mm Cu, and 10 to 20 minutes' exposure.

One week after treatment the animals were killed by a blow over the neck. Each entire animal was ground three times through a meat chopper and the resulting material was transferred quantitatively to a large glass bottle. Ten parts (by weight) of distilled water and a few cubic centimeters of chloroform were added, and the tissue was extracted at room temperature for from 36 to 48 hours with occasional vigorous shaking. At the end of the extraction period and after a final thorough shaking, a portion (300–500 c.c.) of each extract was centrifuged and filtered through coarse filter paper. The various determinations were made on this filtrate. All analyses were made at least in duplicate, beginning with the original extract. The ages, weights, dose of x-ray, and time of extraction are shown in Table I.

Results—The resulting values, except for phosphatase activity, fell within a very narrow range. The average values for phosphatase activity, total phosphorus, inorganic phosphorus, chlorides, calcium, magnesium, sodium, and potassium are given in column graphs in Figure 1. Except for phosphatase, the concentrations are given in milligrams per 100 c.c. (which represents the material extracted from 10 gm of tissue). The phosphatase activity is expressed in milligrams of inorganic phosphorus liberated in one hour at 38° C. from a substrate of sodium B-glycero-phosphate (maintained at pH 8.8 by a NaOH-glycine buffer mixture) by the enzyme in 100 c.c. of extract.

The phosphatase activity of the irradiated animals showed a definite decrease as compared with the controls. This difference, while not as marked as we had previ-

¹ Received for publication July 19, 1934.
The expense of this investigation was aided by the Fluid Research Fund.

the water with which the solutions are prepared, or by iron dissolved out from cracks in the enamel of trays, regardless of the developing solutions employed. This iron staining does tend to occur a little more readily at higher temperatures.

Formalin possesses a pungent odor and is rather irritating to the mucous membranes but it is not considered harmful. Pathologists work constantly in much higher concentrations than are recommended here. If used in tanks, the odor is hardly noticeable and those who use trays seldom do a large enough volume of work at one time to find this feature very undesirable.

SUMMARY

A method is presented for the processing of x-ray films at high temperatures without the necessity of cooling the solutions. Films processed at temperatures up to 95 degrees F by this method are in no way inferior to those processed at the ideal temperature of 65 degrees F.

I wish to express my appreciation for the assistance received from the Eastman Kodak Company, and especially from their representative, Mr Charles W Smith.

TABLE I

Animal number		Age of litter at time of treatment (days)	Dose of x-ray (roentgens)	Weight at time of treatment (grams)	Weight at time of sacrifice (grams)	Duration of extraction (hours)
Control	D1-C1	Preliminary*				
	D1-C2	25	None		785	48
	D1-C3	25	None		810	48
	D1-C4	25	None		760	48
	Avg	25			785	48
Treated	D1-X1	25	550		695	48
	D1-X2	25	550		710	48
	D1-X3	25	550		765	48
	Avg	25	550		723	48
Control	D2-C1	31	None	970	1,265	36
	D2-C2	31	None	935	1,140	36
	D2-C3	31	None	930	1,185	36
	Avg	31		945	1,197	36
Treated	D2-X1	31	1,100	1080	1,010	36
	D2-X2	31	1,100	1025	945	36
	D2-X3	31	1,100	970	875	36
	Avg	31	1,100	1025	943	36

* This animal was sacrificed before the others and used to determine the amounts of extract to use for the various determinations

SUMMARY

Three young rabbits from each of two litters were given 550 to 1,100 roentgens of deep x-ray over the entire body, the three other animals from each litter being used as controls. At the end of one week after treatment all twelve of the animals were killed, ground in a meat chopper, and extracted with ten parts (by weight) of distilled water. The extract was studied for phosphatase, total phosphorus, inorganic phosphorus, chlorides, calcium, magnesium, sodium, and potassium. The phosphatase activity of the irradiated animals was appreciably lower than that of the corresponding controls. No appreciable changes could be detected in the concentration of any of the other substances studied, indicating that some further factor is responsible for the reduction of phosphatase activity.

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ously found in growing dog bone, was significant, since within a given litter the highest phosphatase activity among the decrease *in vivo* as indicated in the *in vitro* assays. At best, evidence of this nature is indirect.

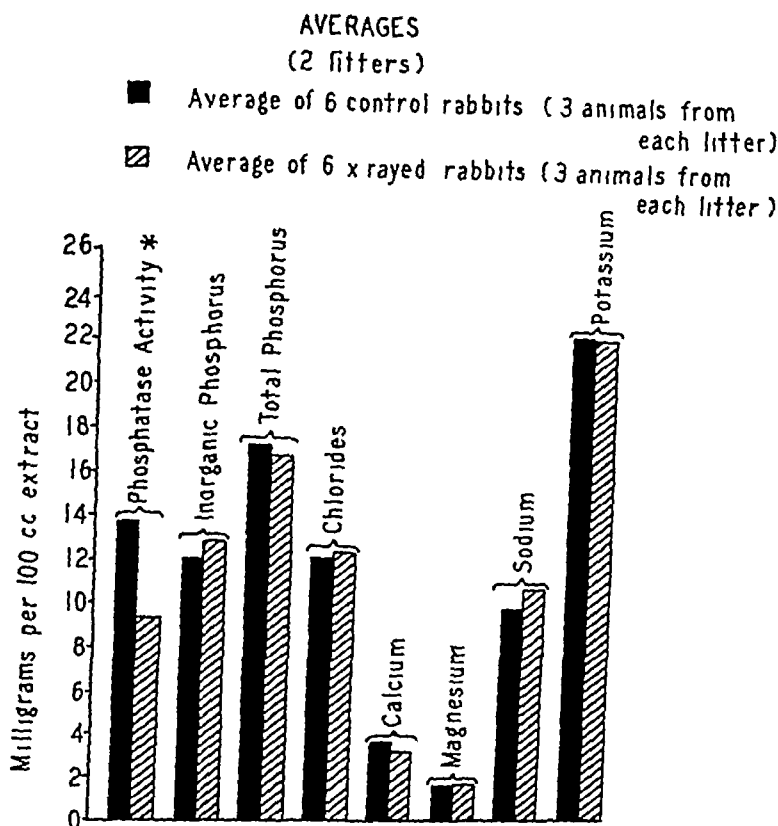


Fig 1

* See text for definition of the unit

treated animals was below that of the lowest among the controls. In an experiment of this kind any change in the phosphatase activity of a given tissue may, of course, be masked by differences in other tissues. In unpublished studies we have found, for example, that while x-ray decreases the phosphatase activity of kidney, the decrease is much less marked than in growing bone subjected to a similar dose.

Whether the decrease is actual or merely apparent, due to inhibitory substances, we cannot say. Also, we are unable to say whether or not there is a functional

Phosphorus, calcium, and magnesium are known to influence phosphatase activity at least *in vitro*, and we were particularly desirous of determining whether changes in the concentration of one or more of these were responsible for the lowered phosphatase activity following x-ray therapy. As regards the inorganic substances studied, we feel entirely safe in stating that the decrease in phosphatase activity found in the irradiated animals cannot be attributed to changes in concentration of phosphorus, chlorides, calcium, magnesium, sodium, or potassium.

TABLE I

Animal number		Age of litter at time of treatment (days)	Dose of x ray (roentgens)	Weight at time of treatment (grams)	Weight at time of sacrifice (grams)	Duration of extraction (hours)
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	D1-X2	25	550		710	48
	D1-X3	25	550		765	48
	Avg	25	550		723	48
Control	D2-C1	31	None	970	1,265	36
	D2-C2	31	None	935	1,140	36
	D2-C3	31	None	930	1,185	36
	Avg	31		945	1,197	36
Treated	D2-X1	31	1,100	1080	1,010	36
	D2-X2	31	1,100	1025	945	36
	D2-X3	31	1,100	970	875	36
	Avg	31	1,100	1025	943	36

* This animal was sacrificed before the others and used to determine the amounts of extract to use for the various determinations

SUMMARY

Three young rabbits from each of two litters were given 550 to 1,100 roentgens of deep x-ray over the entire body, the three other animals from each litter being used as controls. At the end of one week after treatment all twelve of the animals were killed, ground in a meat chopper, and extracted with ten parts (by weight) of distilled water. The extract was studied for phosphatase, total phosphorus, inorganic phosphorus, chlorides, calcium, magnesium, sodium, and potassium. The phosphatase activity of the irradiated animals was appreciably lower than that of the corresponding controls. No appreciable changes could be detected in the concentration of any of the other substances studied, indicating that some further factor is responsible for the reduction of phosphatase activity.

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ously found in growing dog bone, was significant, since within a given litter the highest phosphatase activity among the decrease *in vivo* as indicated in the *in vitro* assays. At best, evidence of this nature is indirect.

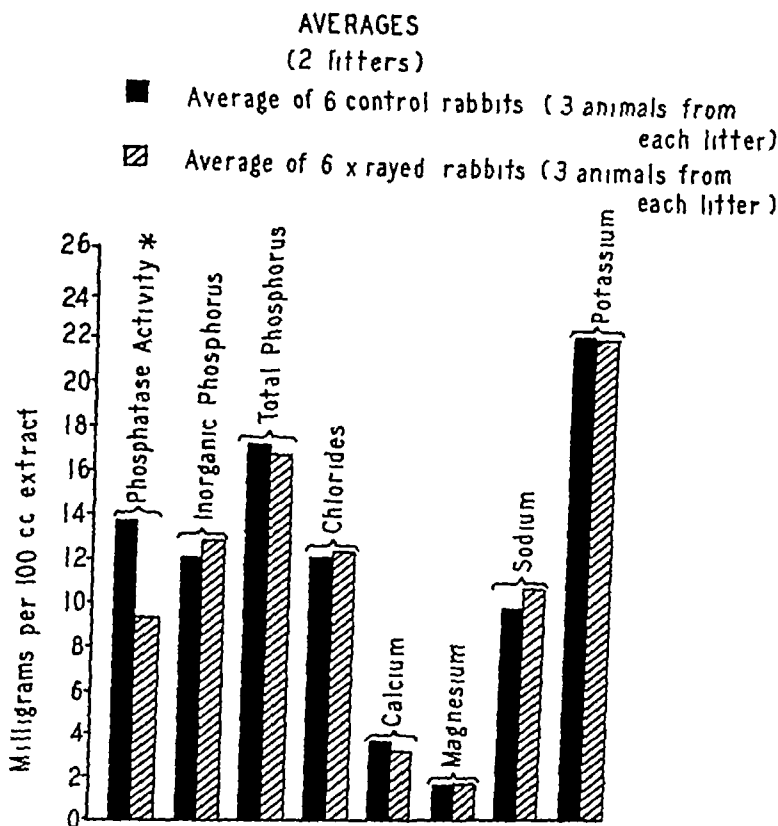


Fig. 1

* See text for definition of the unit.

treated animals was below that of the lowest among the controls. In an experiment of this kind any change in the phosphatase activity of a given tissue may, of course, be masked by differences in other tissues. In unpublished studies we have found, for example, that while x-ray decreases the phosphatase activity of kidney, the decrease is much less marked than in growing bone subjected to a similar dose.

Whether the decrease is actual or merely apparent, due to inhibitory substances, we cannot say. Also, we are unable to say whether or not there is a functional

Phosphorus, calcium, and magnesium are known to influence phosphatase activity at least *in vitro*, and we were particularly desirous of determining whether changes in the concentration of one or more of these were responsible for the lowered phosphatase activity following x-ray therapy. As regards the inorganic substances studied, we feel entirely safe in stating that the decrease in phosphatase activity found in the irradiated animals cannot be attributed to changes in concentration of phosphorus, chlorides, calcium, magnesium, sodium, or potassium.

phylaxis into every group to which they gain access. They are performing a splendid service in the interest of humanity.

The American College of Surgeons, one of America's outstanding surgical bodies, has for several years been actively interested in cancer diagnosis and treatment. It has been my good fortune to have become personally acquainted with some of the leaders of this College and to learn of the extensive program of cancer research which the College is undertaking and sponsoring. Not only has the American College of Surgeons assisted in standardizing a great many of America's public and privately owned hospitals, but it has also been engaged in establishing cancer clinics throughout the United States wherever it finds a hospital or a clinical group sufficiently equipped both by personnel and apparatus to render a true cancer service in the community. This movement has accomplished more, perhaps, than that of any other single organization or group of organizations in America.

The American Medical Association, with a membership representing practically all ethical practitioners of medicine and surgery in the United States, is conducting a series of national network radio programs which reach the public in practically every town and hamlet throughout the country. These programs of cancer education are expressed in a language that every one can understand, and are, therefore, a tremendous help to our national cancer campaign.

Another very worthy activity is the work being done by one of the world's largest life insurance companies—an effort which is accomplishing something that would be practically impossible by the average medical or surgical group. Over the name of this insurance company, full-page statements are being made to the public through our leading national magazines, calling attention to the necessity of combating cancer by the closest possible co-operation with the regular medical profession. Attention is called to the neglect on the part of the average

sufferer in seeking the proper kind of advice—often bringing disastrous results at the hands of the charlatan, the quack, or some other ignorant and unqualified cultist. These published warnings state, in no uncertain terms, that the only effective agent for combating cancer at the present time is the skillful professional use of surgery, x-rays, and radium. For this splendid and voluntary co-operation from an organization fully qualified to speak with authority, the medical profession, as well as the general public, owe a debt of sincerest appreciation and deepest gratitude.

Many other individual private hospitals which have been endowed by public-spirited citizens are augmenting cancer investigation, research, and treatment in a highly commendatory manner. It is impossible to name all, but I wish especially to mention the Rockefeller Institute, which maintains a splendid laboratory devoted to this work, the Memorial Hospital of New York, under the able guidance of that stalwart American scientist, Dr. James Ewing, Johns Hopkins Hospital and University of Baltimore, with Howard Kelly, Curtis Burnam, and the dean of all American cancer students, Joseph Colt Bloodgood, the Crocker Foundation of New York, under the leadership of Francis Carter Wood, whose contribution to cancer research through the "American Journal of Cancer," of which he is Editor, has opened our eyes to the magnitude of the cancer problem, the Steiner Cancer Clinic of Atlanta, Georgia, the Christian Cancer Foundation of the University of Minnesota, the Harvard Cancer Commission, and several others.

Returning to California, mention must be made of the California Institute of Technology, where America's outstanding physicist, Dr. R. A. Millikan, has developed scientific research on a parallel second to none. It was here that the writer first became interested in (real) short wave x-rays, and it may be news to some of our audience to know that in this institution the first experimental treatment of a cancer patient by means of

THE ORGANIZATION OF THE CANCER CAMPAIGN IN THE UNITED STATES OF AMERICA¹

By ALBERT SOILAND, M D , *Los Angeles, California*

Secretary of the United States Delegation to the Fourth International Congress of Radiology, Zurich, Switzerland

THE honor of being permitted to present before this distinguished group of international medical experts the organization of the cancer campaign in the United States of America is deeply appreciated. There is, in all the world, probably no greater responsibility before the medical profession to-day than that of a solution, if humanly possible, of this most devastating disease of modern civilization. It is not a single problem nor a simple one. It demands, first, the education of those lethargic members of our own profession to awaken them into the realization of a duty which is so pertinently their own. Next, to intensify and amplify this education to a point that it may spread over onto the whole public at large in a manner which will remove the fear of cancer and encourage the seeking of assistance from medical advisors at a time when the disease can be scientifically and successfully subjugated. Thirdly, the nation's very government should be made to realize the highly important economic phase of this problem, to the end that appropriations should be directed into channels of scientific research in order that the people may learn, live, and prosper according to their rightful fundamental heritage.

The writer realizes full-well that in the short ten minutes allotted this subject, only the briefest kind of a survey is possible, hence he craves your indulgence for this sketchy and necessarily abbreviated report.

The United States Government is one of the few remaining nations which has not officially, as yet, recognized cancer as a major civic and economic problem. In other words, there is here no national gov-

erning body with authority to investigate into and seek ways and means to check the ravages of this devastating scourge of modern civilization—cancer.

As far as the writer is aware, only two States in the union, New York and Massachusetts, have state-controlled institutions where cancer research and cancer treatment are afforded their constituent citizens, and he is happy to state that both these institutions are under the control of high-grade medical men skilled in the direction and use of all modern weapons of warfare against this disease, including surgery, adequate x-ray equipment, and ample radium facilities. There are also several States, of which California and Pennsylvania are pioneers, where cancer commissions, sponsored by their state medical societies, are doing splendid work in publicizing the importance of cancer study and control to their own medical members and to the public at large. That this is bearing fruit is evidenced by the fact that the public is becoming more cancer-minded, thus co-operating with their medical advisors in the earlier stages of the disease, permitting the proper kind of treatment to be instituted at such a time as may assure a permanent cure, which otherwise would be impossible.

In addition, there is in America a privately endowed organization known as the American Society for the Control of Cancer, which is doing a monumental service for our public. This Society, with its director and headquarters in New York, has a number of highly qualified medical men who act as field agents and district representatives in various parts of the United States. These men call on the physicians in their territory and appear before the local medical societies, carrying the message of cancer education and pro-

¹ Presented before the Fourth International Congress of Radiology at Zurich, Switzerland, July 24-31, 1934.

A ROENTGEN SIGN FOR SACCULAR ANEURYSM OF THE THORACIC AORTA

A PRELIMINARY REPORT

By E. BURVILL-HOLMES, M.D., *Conshohocken, Pa.*

From the Department of Roentgenology, Philadelphia General Hospital

ARE we dealing with a newgrowth or a thoracic aneurysm? This is a question to which the roentgenologist must frequently supply an answer in those cases in which the roentgenogram reveals a shadow of greater or less extent in the upper mediastinum. We say "frequently" advisedly, since aneurysms of the aorta are met with less commonly than formerly owing to the notable discovery by Ehrlich and the marked advancements that have taken place in recent years in the treatment of syphilis. However, they are, even now, by no means a rarity.

That the roentgenologist has to be the court of last resort in differentiating between these two lesions is due to the fact that the clinician, despite the history, symptoms, and physical examination, is not uncommonly at a loss to arrive at a definite conclusion. "A mediastinal tumor or aneurysm" is as far as he will venture, so that, to use the colloquial expression, he "puts it up" to the roentgenologist to render the final verdict. And, too, it is not only necessary to establish a diagnosis for diagnosis' sake, but upon its accuracy depends the institution of the proper remedial measures. In passing, it might be of interest to note that 10 per cent of our cases of aneurysms were clinically diagnosed pulmonary tuberculosis.

It is not our purpose here to discuss the pathology of aortic aneurysms further than to say that in our opinion all saccular aneurysms of the aorta are the result of syphilis. We anticipate some criticism for this statement but, nevertheless, it is our belief. It is true that in 10 per cent of our cases, serology was negative in all antigens, but laboratory findings are equally disappointing in cases in which syphilis is unquestioned. Furthermore, it

is also true that in perusing the case histories of many of the patients in whom saccular aneurysms existed, and were subsequently substantiated with autopsy, we read that the patient disavowed a primary lesion. This we can, and do, attribute to the manner in which the history was elicited. To obtain honest and informative replies care must be taken in the wording of the question. "Have you ever had a sore?" will invariably meet with a denial for the reason that, the patient being only human, any reflection on his or her morals would dictate the answer "no," regardless of what the truth might be.

We always submit the patient to the psychological effect of roentgenoscopic examination and, at its conclusion, bluntly and without equivocation inquire, "How many years ago did you have a sore?" In this way we have never yet failed to secure a frank confession.

Boyd mentions infections such as influenza, typhoid, pneumonia, etc., as probable causes of adventitial inflammation, but adds that it is doubtful if sufficient weakening of the walls takes place to lead to aneurysm. He also says "An infected embolus lodging in the vessel and extending to the media may cause a mycotic aneurysm. Congenital weakness of the media or a tuberculous mediastinal gland in contact with the aorta, giving rise to a local infection, as the result of which the wall may give way, may result in aneurysm." However, he concludes, "At best, these causes are so rare as to be doubtful."

Excluding the dissecting, true, false, and circoid, etc., we class all aneurysms as saccular. We do not subscribe to fusiform aneurysms. We do meet with fusiform dilatations but not fusiforman-

at a voltage over a half-million, took place in the Fall of 1930. At that time Dr. C. C. Lauritsen, Associate Professor of Physics, working under Dr. Millikan, had been experimenting with the higher voltages and a vacuum tube of his own design and manufacture, in endeavoring to break down the nucleus of the atom. These gentlemen were finally prevailed upon to submit their apparatus to clinical tests upon patients with cancer beyond the reach of surgery or other therapeutic means. From this small beginning the California Institute of Technology has continued experimental treatment work upon cancer sufferers up to the present time, this Fall completing four years of clinical research work with voltages up to 1,200,000. It is hoped that very soon an official report upon this work may be forthcoming.

In addition to the foregoing there are a number of individuals, and their name is legion, who have sacrificed their very lives in an altruistic endeavor to control cancer by means of radio-active agents. It was my intention to name a few among

those still living who have contributed so much to our knowledge of cancer treatment, but the task assumed such startling proportions that it was deemed best to omit it. I started out to select those of whom I had personal knowledge, and also ran over the list of radiological authors who had contributed meritorious articles through the medical press. It appeared, however, that it would be impossible to include a list of all such, without injustice, so I would suggest that, if one glances through the fellowship roster of the American College of Radiology, he will probably find therein those who have placed clinical radiology upon the highly respected professional plane it now occupies in the United States of America.

It is earnestly hoped that the results of the cancer campaign reports before this distinguished body of physicians and physicists at the Fourth International Congress of Radiology will prove of inestimable value to the members participating, and that the lessons therefrom may redound to the health and happiness of all mankind.



Fig 2 Saccular aneurysm of the horizontal branch of the thoracic aorta Negress, 24 years old Note angle



Fig 3 Saccular aneurysm of the distal horizontal and proximal descending branch of the aorta Note well defined semicircular indentation

made in the right and left anterior oblique and sagittal projections. These latter are imperative if we are to detect any erosion of the vertebræ such is usually the case when the sac is large and projects dorsal-ward. In a single case we were enabled to demonstrate marked vertebral destruction in a dorso-ventral projection (Fig 1).

Deviation of the esophagus, while not always present, is usual, but similar displacement can, and often does, occur in tumors. To determine this displacement it is our custom to administer a thick barium-buttermilk paste. A thick paste is utilized since it will remain *in situ* for a sufficiently long time to secure the necessary roentgenograms in all positions. Again, aneurysms practically always cast a markedly dense, homogeneous shadow for reasons which are obvious: newgrowths frequently exhibit similar density. In contra-distinction, however, fusiform dynamic dilatations, often erroneously diagnosed fusiform aneurysms, cast a

shadow much less dense because the laminated clot is absent. Given a roentgenogram in the case of a negro in which a large, homogeneous shadow occupies the upper mediastinum, by the law of averages a diagnosis of aneurysm would undoubtedly be confirmed. But, while less common in this race than in the white, tumors are met with. As newgrowths occur less often in the negro than in the white, so do aneurysms in our experience, and in this country, occur more frequently.

What, then, is the diagnostic feature in the roentgenogram which provides the key to differentiate? For some time past we have made the observation that in all aneurysms, with the exceptions before mentioned, there is always a definite angulation between the outer limit of the sac wall and the left border of the heart. It may be a right-angle or an obtuse one; it may appear as a small arc of a circle. Perhaps the word "indentation" would be more descriptive. Furthermore, and this is of equal importance, is the inability to



Fig 1 Extensive destruction of the left half of the bodies and laminae of the third fourth fifth sixth, and seventh dorsal vertebrae by a large sacular aneurysm of the horizontal arch and proximal descending branches of the thoracic aorta Dorso-ventral view

eurysms We have experienced several cases in which the entire left hemithorax would be practically occupied by a large, fusiform-shaped dilatation of the descending branch which would probably be classed as a fusiform aneurysm Nevertheless, at autopsy, a vessel will be found of normal size but with walls of "paper-like" thickness These are fusiform dynamic dilatations often associated with marked tortuosity and are not fusiform aneurysms In the past four years we have encountered, at the Philadelphia General Hospital, aneurysms as follows

Horizontal branch 22
Distal, ascending and horizontal, 19
Proximal descending 18
All branches 9
Proximal ascending, 5
Proximal descending 5

In addition we have had but have excluded as irrelevant to the report, two distal descending thoracic, two abdominal, and three of the common innominate

As we have remarked before, it is often

ROENTGEN DIAGNOSIS

difficult, indeed impossible, to clinically differentiate tumors of the upper mediastinum from aneurysm Pain, hemoptysis, cough, and physical findings are common to both, so that dependence has to be given to roentgenographic and roentgenoscopic findings

Right here and now let us explode the common impression that a differential diagnosis between tumor and aneurysm can be made, by noting on the fluoroscopic screen pulsations of the latter and their absent in the former In our experience, pulsation of the sac is decidedly the exception rather than the rule, probably because when these cases come under our observation the aneurysm has existed for a long time And even in the few cases in which pulsations are observed it is often impossible to say whether such pulsation is expansile or transmitted One has but to inspect the contents of one of these sacs at the autopsy table to readily appreciate why pulsations do not occur, or are so infinitesimal as not to be visible on the fluoroscopic screen The blood coursing through a narrow channel precludes any appreciable registration of the pulse wave, owing to the layer upon layer of dense, laminated clot, which intervenes between it and the sac wall

Our patients, nevertheless, are routinely examined by fluoroscopy though this procedure is not absolutely essential for diagnosis In virtually all cases a dorso-ventral roentgenogram of the chest rarely betrays us, with the exception of those aneurysms that involve the proximal ascending or distal descending branches, or in the rare cases in which the aneurysms are so small and so situated that they could be, and are, overlooked by any method of examination In referring to the summary of our cases it will be noted that these exceptions constitute a very small portion of the total However, for further refinements in diagnosis, in order to determine which portion of the branch, or branches, is involved, roentgenograms are

this case is not proven (since the patient, after a few days in the hospital, requested and received her discharge), however, we feel sure that, despite the patient's age, she has an aneurysm. We might add that, before her discharge, we were informed that serological tests were strongly positive in all antigens.

Another patient, also a negro, aged 49, was on the service of Dr William Drayton in the psychological department. His chief complaint was intense pain in the chest. The pains, he stated, began five years before admission, in the left shoulder, migrating to the chest. For the past two years, however, he had been free from it but it returned six months ago. When he lies down he becomes very dyspneic. According to his past medical history he had "blood poisoning" ten years ago. He, however, denied a primary lesion. Physical examination showed impaired fremitus over the left chest, with impaired percussion note. Over this side, also, breath sounds were distant and a few expiratory râles were present. There was no precordial bulging. The apex was visible and palpable in the fifth interspace inside the midclavicular line. There were no thrills. Heart sounds were normal and no murmurs or bruit could be detected. Blood pressure on both sides 140/90. Serology was as follows: chol antigen, one plus, Nogouchi, minus, Kahn, three plus. A clinical diagnosis was made of either mediastinal newgrowth or aneurysm. Autopsy showed a large saccular aneurysm involving the distal horizontal and proximal descending branches. The aneurysm had ruptured into the left upper lobe of the lung (Fig 3).

This film, likewise, caused no little discussion and opinions were varied. The widespread shadow, occupying much of the left hemithorax and lacking any well-defined outline, tended to confuse and confound. Here again the angle could be demonstrated, although faintly, and furnished the basis of a roentgen report of a saccular aneurysm.

Figures 4-A and 4-B are illustrative of

the signs to which we have drawn attention. I M, negro, aged 46 years, was admitted to the nervous wards on the service of Dr Yaskin, because of a left-sided hemiplegia. Owing to his inability to talk, only a brief history was obtainable, but his wife who acted as informant said that he had been a regular attendant at an out-patient clinic, where he was given "shots" in the arm for "bad blood." Upon awakening in the early morning of the day on which he was admitted to the hospital, she found him paralyzed, being unable to talk or move his left arm and leg.

In conclusion, we do not wish to convey the idea that this angle will be present in every case, or that, if present, it is infallible for a diagnosis of aneurysm. There are exceptions to all rules. It is conceivable that a large upper mediastinal tumor could extend outward and downward on the left side, obscuring the left border of the cardiac shadow, and that its upper border might form an angle with the latter. This must be rare, however, as we have never yet experienced it. An error, if it is made, will lie largely in mistaking a newgrowth for an aneurysm rather than the reverse.

The patient had a large pulsating mass in the supraclavicular region of the right side. It was freely movable and an auscultatory bruit was heard over it. There was no precordial bulging, but there was a widespread heaving pulsation. No palpable shock or thrill was felt. The heart was greatly enlarged as evidenced by the area of cardiac dullness. A systolic and diastolic murmur was appreciable. Pulse was of the water hammer type. Blood pressure was 190/68 on the right arm and 160/82 on the left. Blood and spinal fluid was 4 plus in all antigens, and a paretic gold curve was obtained.

In the light of the history, physical and laboratory findings, a clinical diagnosis of right cerebral thrombosis, cardiovascular syphilis, with aneurysm of the aorta and innominate, was made. In referring to the reproduction of the roentgenogram of the patient's chest, it will be noted that there



Fig 4 A Erroneously interpreted as an aneurysm. Note the absence of solid angle and the visualization of the left border of the heart through the mass (more clearly outlined on the film)

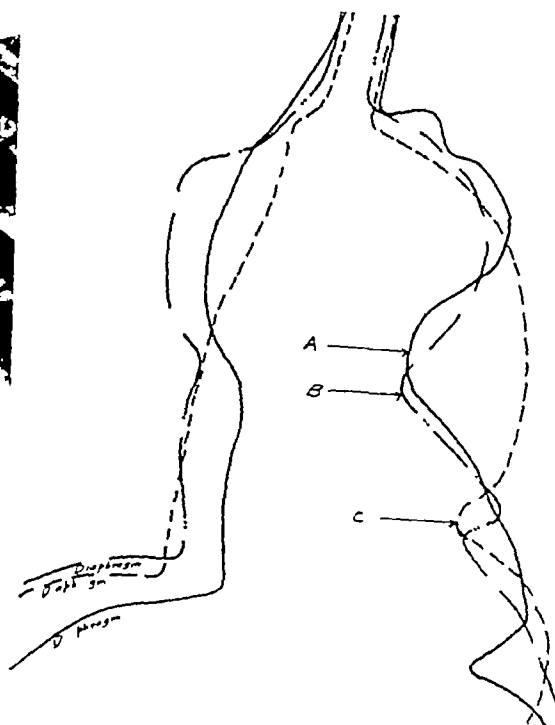


Fig 4-B Composite line drawing of three aneurysms. Note angles at A, B and C

trace the left border of the heart beyond the lower limit of the sac wall. The border of the heart fuses, as it were, with the dense shadow of the aneurysmal sac. Occasionally it can be traced beyond the latter, but, if so, only for a distance of approximately one to two centimeters. In contrast, in cases of tumor, this angulation is not present, and the border of the heart can be traced from its apex to the aortic arch. The idea which we wish to convey will be more readily understood if reference is made to the accompanying roentgenographic reproductions (Figs 2 and 3) and also the lined drawing—a composite of three aneurysms (Fig 4).

Figure 2 is a case on the service of Dr McLean, from the department of tuberculosis. The patient was a negress, aged 24 years, whose chief complaint was pleuritic pains over the left lower chest for the previous five days. Her history was that about a month prior to admission she be-

gan to lose weight, but her appetite remained good until five days before, at which time she became weak and listless. There was never any cough, expectoration, or hemoptysis. Five days before admission she suffered with sudden, stitch-like pains which were worse on deep breathing but were relieved by strapping. Physical examination was virtually negative, and the sputum negative for tubercle bacilli. The patient was referred to the x-ray department with a clinical diagnosis of pleurisy and a tentative one of pulmonary tuberculosis.

The film of this patient prompted much discussion and opinions were divided as to whether it was a newgrowth or aneurysm. Because of the youth of the patient a majority considered aneurysm as entirely problematical, but the telltale angle was present and we unhesitatingly made a diagnosis of saccular aneurysm of the horizontal branch of the aorta. While

ROENTGENOLOGIC METHOD OF EXAMINATION OF THE LYMPHATIC SYSTEM IN MAN AND ANIMALS¹

By A. ZOLOTUKHIN, *Leningrad, U S S R*

From the Laboratory of Normal and Comparative Anatomy at the State Roentgenologic,
Radiologic, and Cancer Institute

(Director of the Institute, Professor M. I. Nemenow, Head of Laboratory,
Professor A. Zolotukhin)

IN 1928, at the suggestion of Professor M. I. Nemenow, the Director of the Institute, our laboratory took up the task of working out a roentgenologic method of examining the lymphatic system. Owing to the fact that there is not a single branch of practical medicine which is not interested in the lymphatic system and considering the importance, the difficulty, and the responsibility of the work, the laboratory set about the task, having included it in the plan of its work as one of the main problems.

The first year of work resulted in reassuring findings, as it enabled us to answer in the affirmative the question as to whether or not it was generally possible to introduce a contrast substance into the lymphatic system of a living animal and to have it reproduced by means of a roentgenogram.

The experiments were carried out on frogs, as the introduction of a contrast substance into their large subcutaneous pouches presented no difficulty. The frog was either slightly anesthetized or even received no narcosis whatever, and a number of serial roentgenograms were then made, revealing the penetration of the contrast substance into both the anterior and posterior lymphatic hearts. The frogs bore the experiment well and as a rule survived, so that it was possible to make further roentgenograms at differ-



Fig 1

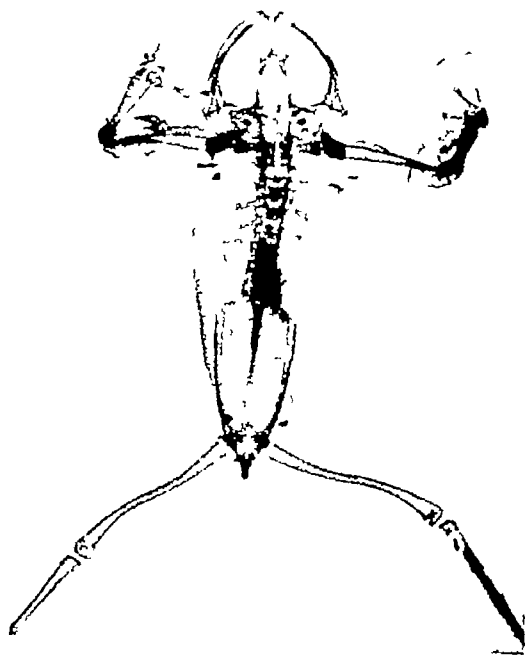


Fig 2

¹ In a personal communication the author says "Generally speaking all the data appearing in this article will first appear in RADIOLOGY. The data obtained in 1928 as a result of the experiments on frogs have not yet been published and have not been communicated to anyone. The same can be said of the data obtained on rabbits." The literature available to him writes the author does not contain any earlier communications on the investigation of the lymphatic system by means of the roentgen ray.

ent intervals up to the twenty-first day. In a number of cases the contrast sub-

is an absence of the solid angle invariably seen in cases of saccular aneurysm of the aorta. Furthermore, and just as important, the left ventricular border can be traced through the shadow of the circumscribed mass (more sharply defined on the original film).

That the signs were of value in refuting the opinion that no aneurysm was present was borne out by the postmortem findings. No evidence of any aneurysm either of the aorta or innominate was found. The former was considerably dilated and presented many diffuse and puckered scars with wrinkling of the intima. The dilatation was fusiform, the caliber of the arch being 10 centimeters. The innominate was likewise dilated, with fibrosis of its walls.

SUMMARY

We have attempted, briefly, to describe a new sign whereby tumors of the upper mediastinum can be differentiated from saccular aneurysms of the thoracic aorta.

In the latter, a definite angulation is formed by the lower left border of the heart with the lower border of the aneurysmal sac, in addition, and equally important, is that the left border of the heart cannot be traced through the dense shadow cast by the aneurysmal sac.

While we do not claim infallibility for this sign, our experience has shown that it is of considerable value in the differentiation of the two lesions. We have never observed the sign in cases of tumor.

Figure 2 is one of the serial roentgenograms showing the experiment carried out on Oct 27, 1928 Animal, *Rana temporaria*, male, size, average, small ulcer on the skin of the left upper eyelid,

reproducing the different organs and parts of the body of man and laboratory animals This work has made it possible to give a better grounded and more detailed answer to the question we set out to answer

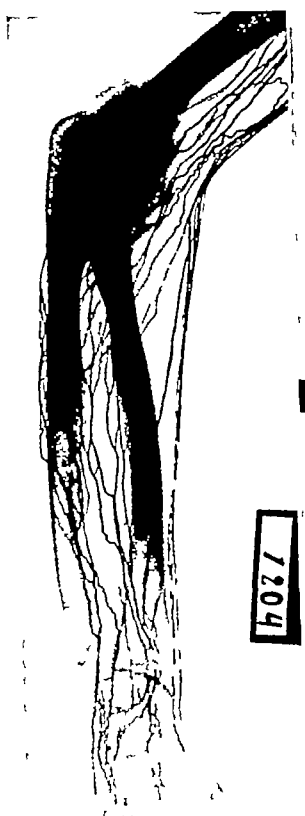


Fig 3



Fig 4



Fig 5

receives neither narcosis nor any pharmacologic administration, subcutaneous injection of 0.1 gm of Bismuth Carb Suspens in gum arabic into the left crural region and of the same quantity into the right humeral region The roentgenogram, taken on Oct 29, 1928, i.e., in 48 hours' time, reveals the accumulation of the contrast substance in the region of the posterior and anterior lymphatic hearts, no connection with the site of injection can be established

In the course of the last two years we have carried out over 120 experiments and have made about 250 roentgenograms

Notwithstanding the facts that in 1929 Defrise demonstrated at the Congress of Italian Anatomists, in Bologna, several roentgenograms of the lymphatic system injected with silver nitrate, that in 1930 Gaetano Ottaviani applied the injection of mercury on human corpses, and those of domestic animals, and that in 1931 Oscar Meller applied umbrathor to the injection of lymphatic vessels of the lungs, it was a fact that, so far as the writer knew, no definite roentgenologic method for examining the lymphatic system had been established

Due to this fact our laboratory deter-

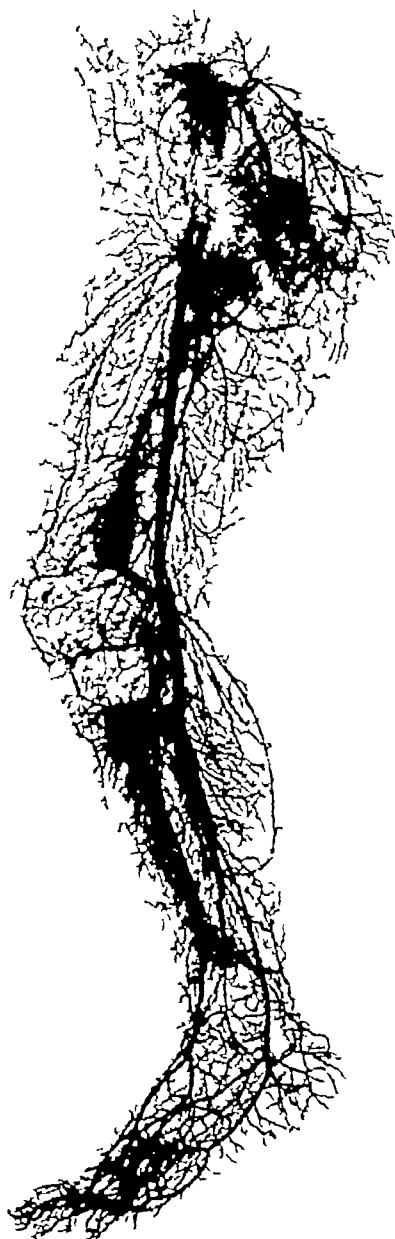


Fig 2 A

stance having disappeared from the lymphatic hearts, it was observed in the spleen. The findings have been the subject of a special paper.*

* A. Zolotukhin, V. Karasik, 1928

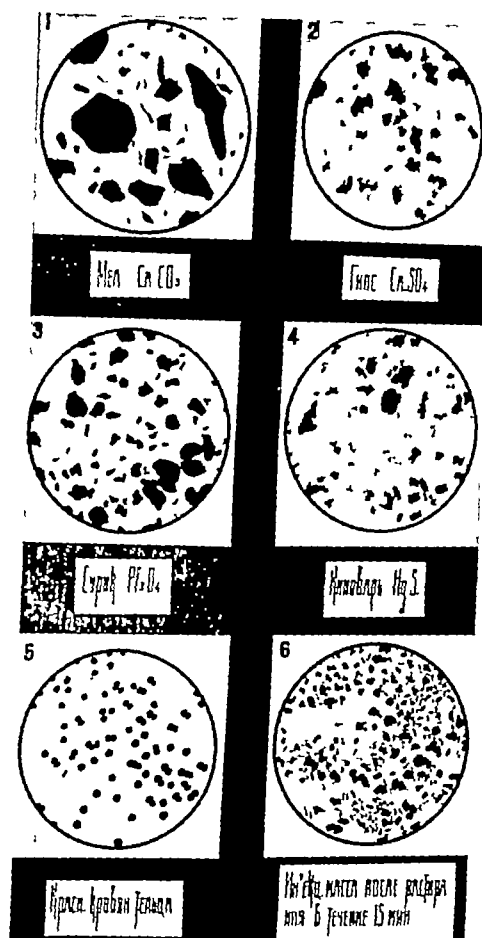


Fig 2 B

Figure 1 is a roentgenogram showing a phase of one of the experiments made Sept 29, 1928. Animal, *Rana temporaria*, male, size, average, no narcosis or any other pharmacologic administration. Subcutaneous injection of (1) 0.3 gram of Sol Natr Brom 20 per cent, into the right crural region, (2) 0.4 gram of Bismuth Carb Suspens into the left crural region. The roentgenogram was made 18 seconds later. It shows distinct outlines of a contrast band on the left which spreads from the shin to the lymphatic heart along the whole of the thigh, and a less marked contrast band on the right which is manifest only within its initial limits, spreading no farther than up to the middle of the thigh.

Figure 2 is one of the serial roentgenograms showing the experiment carried out on Oct 27, 1928 Animal, *Rana temporaria*, male, size, average, small ulcer on the skin of the left upper eyelid,

reproducing the different organs and parts of the body of man and laboratory animals This work has made it possible to give a better grounded and more detailed answer to the question we set out to answer



Fig 3



Fig 4



Fig 5

receives neither narcosis nor any pharmacologic administration, subcutaneous injection of 0.1 gram of Bismuth Carb Suspens in gum arabic into the left crural region and of the same quantity into the right humeral region The roentgenogram, taken on Oct 29, 1928, i.e., in 48 hours' time, reveals the accumulation of the contrast substance in the region of the posterior and anterior lymphatic hearts, no connection with the site of injection can be established

In the course of the last two years we have carried out over 120 experiments and have made about 250 roentgenograms

Notwithstanding the facts that in 1929 Defrise demonstrated at the Congress of Italian Anatomists, in Bologna, several roentgenograms of the lymphatic system injected with silver nitrate, that in 1930 Gaetano Ottaviani applied the injection of mercury on human corpses, and those of domestic animals, and that in 1931 Oscar Meller applied umbrathor to the injection of lymphatic vessels of the lungs, it was a fact that, so far as the writer knew, no definite roentgenologic method for examining the lymphatic system had been established

Due to this fact our laboratory deter-

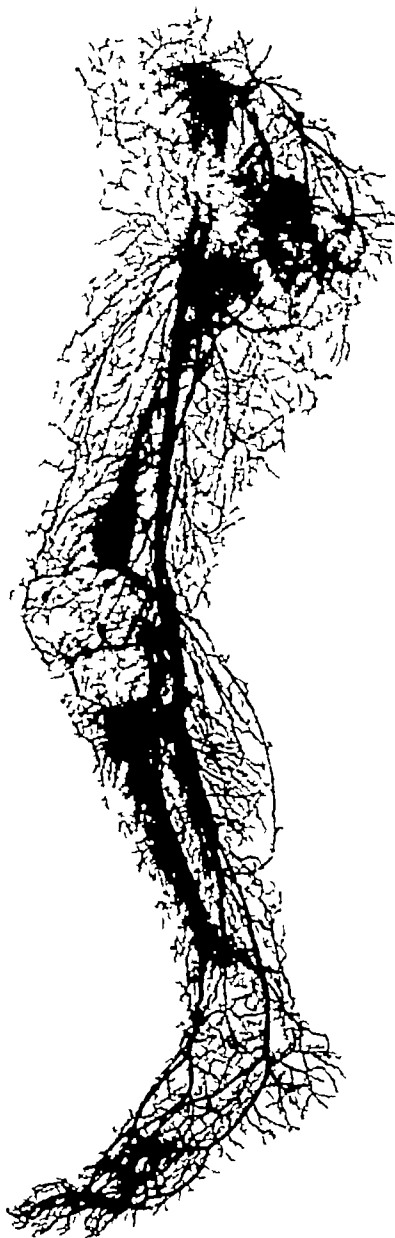


Fig 2 A

stance having disappeared from the lymphatic hearts, it was observed in the spleen. The findings have been the subject of a special paper.²

² A. Zolotukhin, V. Karasik, 1928.

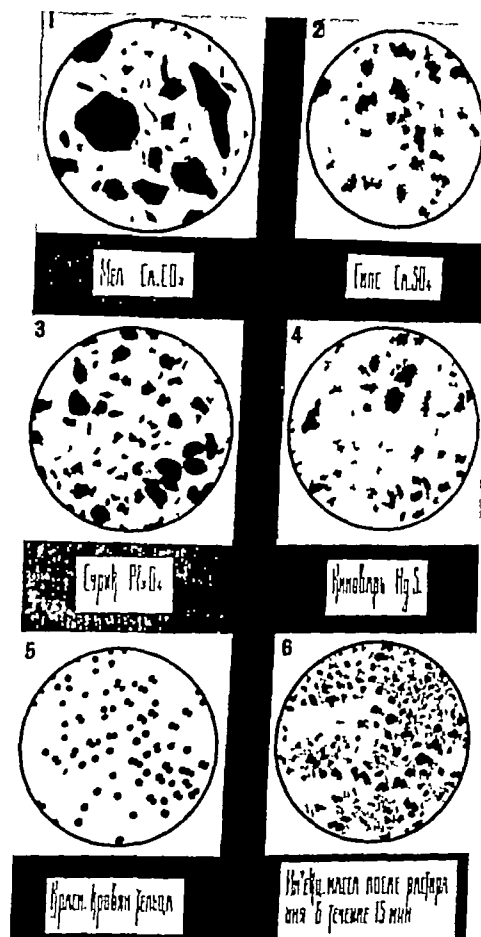


Fig 2 B

Figure 1 is a roentgenogram showing a phase of one of the experiments made Sept 29, 1928. Animal, *Rana temporaria*, male, size, average, no narcosis or any other pharmacologic administration. Subcutaneous injection of (1) 0.3 gram of Sol. Natr. Brom. 20 per cent, into the right crural region, (2) 0.4 gram of Bismuth Carb. Suspens. into the left crural region. The roentgenogram was made 18 seconds later. It shows distinct outlines of a contrast band on the left which spreads from the shin to the lymphatic heart along the whole of the thigh, and a less marked contrast band on the right which is manifest only within its initial limits, spreading no farther than up to the middle of the thigh.

topographic injection with two substances differing in their atomic weights the roentgenogram reproduced as Figure 6

tained in the glandular filter the contrast substance, *i e*, a 30 per cent solution of collargol

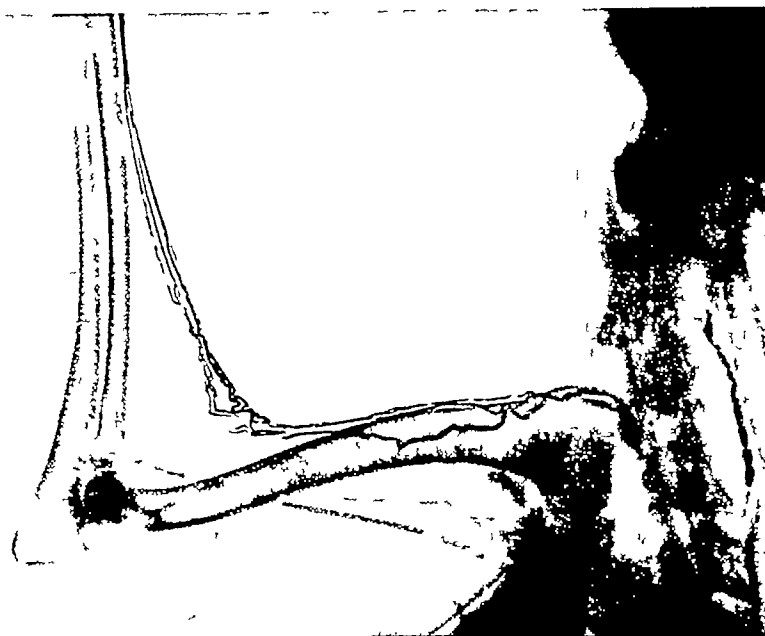


Fig 9

not only shows the subcutaneous lymphatic vessels but the arterial system as well

Figure 7 shows the main subcutaneous lymphatic vessels of the posterior extremity injected with white lead ($2\text{PbCO}_3 \cdot \text{Pb/O/H}_2$). The vessels are satisfactorily contrasted, well outlined, and can be seen even against the background of osseous tissue. The vessels, numbering five (*vasa afferentia*), run toward the lymphatic gland and, having passed through it (*vasa efferentia*), emerge as a smaller number, for only two vessels are then discernible, however, one of the two, namely, that running to the nearest lymphatic gland, again ramifies into three branches.

Figure 8 is a roentgenogram showing an analogous picture with a modified interrelation of contrasts observed in the *vasa afferentia* and the *vasa efferentia* at the expense of the two lymphatic glands being more markedly contrasted, having re-

Figure 9 is a reproduction of the right anterior extremity of a dog and shows a fascicle of superficial lymphatic vessels, consisting of four stems having marked dilatations at the site of valves (*vasa afferentia*). Only two vessels emerge from the gland but those are of greater diameter (*vasa efferentia*) and the cranial one soon bifurcates. In their further course the three vessels considerably increase in diameter, the distinct contours of the truncus jugularis, with marked swellings at the site of valves, being visible in the cervical region.

Figure 10 is a roentgenogram reproducing a topographic, *i e*, complex, injection of three systems—the arterial, the venous, and the lymphatic. Stereoscopic examination reveals the interrelations between the aortic arcs (and the larger branches of the aorta), the vena cava superior, and the lymphatic duct.

All the above-described findings have



Fig 6

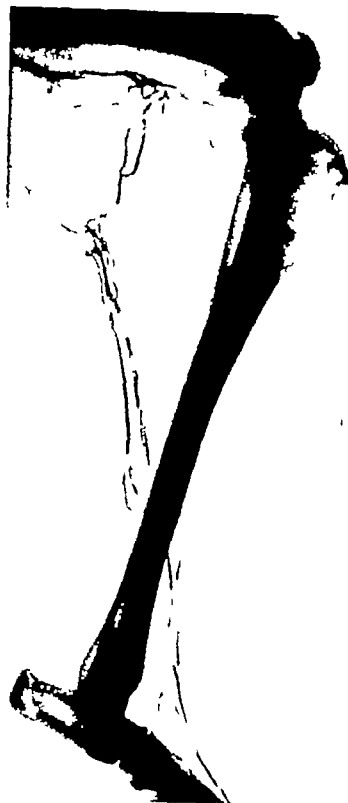


Fig 7



Fig 8

mined on starting with the injection which has been known since the days of Nuck (1692) and has become classical. However, owing to the peculiarities of the roentgenologic method, we considered it essential that any substance introduced for exploratory purposes should be possessed of the contrasting capacity, and that the injection should be complex, *i.e.*, we decided on introducing a topographic injection and thus obtaining a stereoroentgenogram. During the last year the methodical part of the problem set has been considerably advanced since the time when the work was placed in the charge of Dr Jdanov, who has made all the further described anatomic sections.

The following substances have been tested on anatomic material: (1) the essential substances of the Hauch, the Gerota, and the Hazin type, (2) the experimentally obtained modifications of

the latter, and (3) substances worked out at the laboratory by Dr A Zolotukhin and Dr D Jdanov.

Figure 3 is a roentgenogram showing the subcutaneous lymphatic vessels of the upper extremity of an adult, Figure 4, the lower extremity, the injections of mercury having been made into the skin of the finger and the toe, respectively. Such a roentgenogram as Figure 3 is the exact reproduction of the lymphatic system of the forearm and reveals the distribution of the vessels, the nature of the anastomoses of separate branches and their coils, and the line of their direction toward the lymphatic glands. The high atomic weight of mercury is its advantage, its high specific gravity, its drawback, considerably limiting its application.

Figure 5 is a roentgenogram showing the entire thoracic duct of a rabbit.

Owing to the application of a complex,

examination The solution of these problems will render more accurate our knowledge concerning this complicated and important branch of the morphology and physiology of man and animals

METHOD OF PROCEDURE

The following substances have been applied for injecting the lymphatic system in anatomic material (1) the essential substances of the Hauch type, namely, red lead (Pb_3O_4), 120 0 gr , paraffin oil, 120 0 gr , oil of turpentine, 60 0 gr the Gerota type, namely, red lead (Pb_3O_4), 5 0 gr , oil of turpentine, 3 0 gr , chloroform, 5 0 gr the Hazin type, namely, glycerin fl , 100 0 gr , bismuth carb , 20 0 gr , ag destil , 10 0 gr (2) their experimentally obtained modifications, and (3) substances worked out at the laboratory by Dr Zolotukhin and Dr Jdanow, ($2PbCO_3Pb(OH)_2$), 60 0 gr , paraffin oil, 45 0 gr , oil of turpentine, 130 0 grains

The substance injected for roentgenologic examination should meet the following three essential requirements it should be possessed (1) of a contrasting capacity, (2) of a high degree of penetrability, and (3) be fine, *i.e.*, consist of an emulsion with very minute particles or grains

The above-mentioned Hauch's substance may be considered as essentially suitable for the purpose of injecting the blood, vascular system, and the arteries in particular, on condition that its penetrability be increased by a modification in the ratio of its constituents (60 0 gr , 45 0 gr , 80 0 gr , respectively), and that the particles of red lead (Pb_3O_4) be very minute

Figure 2-A is a roentgenogram showing the entire arterial tree of the lower extremity injected with Hauch's substance, the size of the emulsion grain exceeding but slightly the diameter of an erythrocyte

The crushing of the substance applied for injecting is best performed by a mechanized method with the aid of a fine grinding machine such as is used for chemical purposes A porcelain or agate mortar insures a fine grind which is

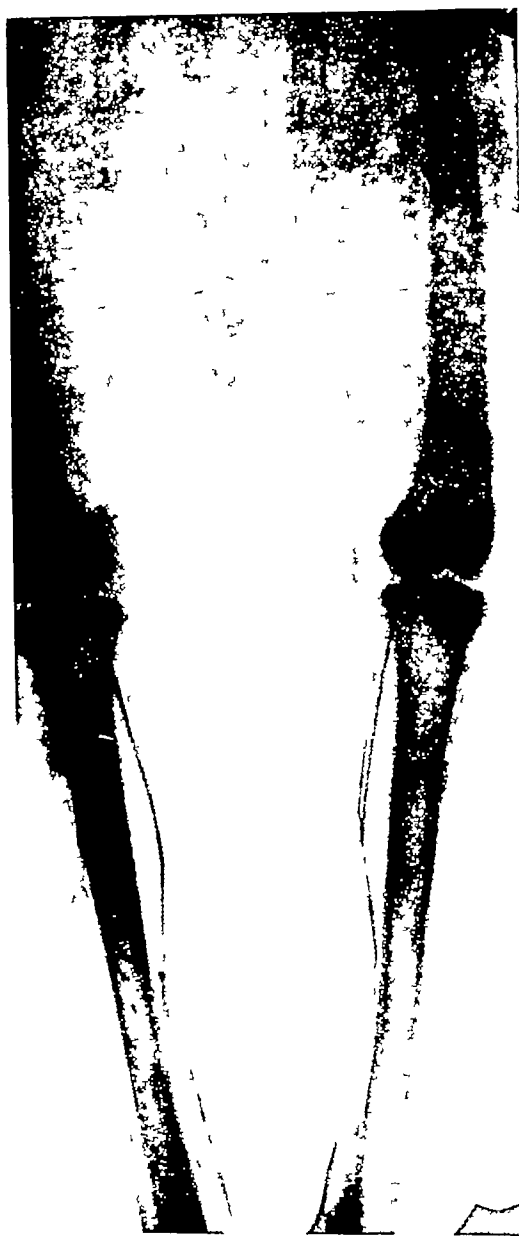


Fig 12

rapidly obtained, while by graduating the contents of the pestle (which sometimes reaches as much as 2500 grm), a standard mass is warranted

Figure 2-B is a tracing, made by means of Abbee's device, for microscopic drawing of the different equally magnified particles constituting the substance used for injection, previous to their having been crushed No 1, $CaCO_3$, No 2, $CaSO_4$,



Fig 10

been reproduced in anatomic sections obtained by means of a special anatomic method of procedure, designed to meet the peculiar roentgenologic requirements.

Figures 11 and 12 are roentgenograms obtained as a result of a physiologic experiment. Rabbits having received a light dosage of anesthetic were injected intracelluarly with a 30 per cent solution of collargol into the anterior extremity and the skin of the toes. The lymphatic vessels, which are well contrasted against the bone, are distinctly visible (Fig 11), they run from the site of injection to the nearest lymphatic glands of the axillar (Fig 11) and popliteal regions. Figure 12 shows the lymphatic vessels of the two lower extremities.

CONCLUSION

On the ground of the work completed it is now possible to affirm that the application of the roentgenologic method to the examination of the lymphatic system of man and animals will doubtless help to bridge over a number of lapses which have so far existed in the fields of morphology and physiology.

The problems consist of establishing the connection between the superficial and the deep-lying lymphatic vessels of

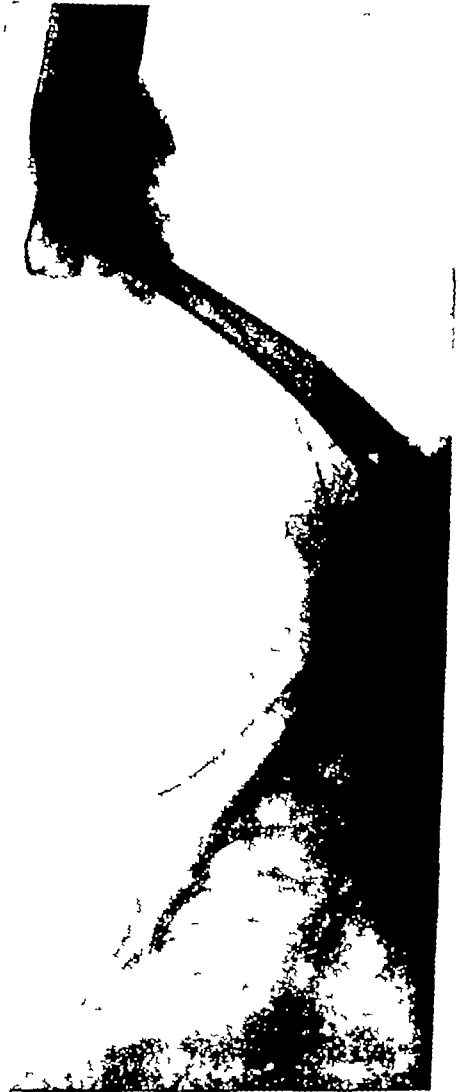


Fig 11

the extremities, those of various organs and of the different regions of the body (such as the mediastinum), as well as the connection between vessels running in different regions, which is of such great importance in practical medicine. These problems and the study of the routes along which the lymph flows, *i e*, the study of lymph circulation under pathologic conditions in particular, are essential problems whose solution may be facilitated and promoted by including in the methodologic complex the roentgenologic method of

A STUDY OF THE EFFECT OF IRRADIATION UPON THE LUMBAR SYMPATHETIC GANGLIA IN RATS¹

By J Q GRIFFITH, JR, M D, Instructor in Medicine and Kerkscher Fellow in Medical Research, and E P PENDERGRASS, M D, Philadelphia

SINCE 1930, we have been interested in the treatment of cases of angina pectoris with roentgen therapy. It was thought that the effect of irradiation, if any, was upon the sympathetic ganglia, and that pain was relieved in a manner analogous to the relief sometimes obtained after alcoholic injection. A similar line of reasoning was used by others in the justification of roentgen therapy in many diverse conditions, including Raynaud's disease, lichen planus, pruritus, and dysmenorrhea. It soon became obvious that it was extremely difficult to evaluate the results. Patients with angina pectoris frequently pursue a very variable course, they are of necessity treated with several therapeutic agents simultaneously. An improved morale and spirit of optimism may in certain cases mislead both patient and physician as to the true progression of the condition. The technic of roentgen therapy entails manipulations which may act powerfully on the psyche. Thus it was found that, while many cases of severe angina showed improvement, and so stated, they all tended to relapse. Other persons with anginoid pains, definite nervous disturbances, but little in the way of organic cardiac findings, might remain permanently improved.

It seemed desirable that some objective experimental data be procured, preferably on animals, bearing upon the basic question: Can roentgen irradiation affect the sympathetic ganglia? The following three possible procedures suggested themselves.

(1) Irradiation of the ganglia *in situ* and subsequent microscopic examination. The objection to this was technical. It is

uncertain what degree of damage to a ganglion must exist before it is apparent in the fixed stained preparations now available. It is probable that an attack upon the problem in this manner would require the development of an entirely new technic.

(2) After ganglionectomy the temperature of the skin which has suffered an interruption of its vasomotor nerve supply will be relatively high, at least for a time. It is customary to compare corresponding parts on opposite sides. This method is satisfactory and simple following operative procedures, which can easily be unilateral. The proximity of the paravertebral ganglia to each other especially in small animals where they may be only from 2 to 3 mm to each side of the midline, practically precludes the use of this method following irradiation.

(3) After ganglionectomy the peripheral sympathetic nerve plexuses, lying in the adventitia of blood vessels, degenerate. This degeneration is complete in from 45 to 60 days. It was realized that failure to obtain this degeneration would not necessarily mean that there had been no effect on the sympathetic ganglia, but only that the effect was not comparable to operative ganglionectomy. This was the method chosen.

Considerable preliminary work was required to determine the dose of irradiation to be employed, and to work out the technic for staining the peripheral sympathetic vascular plexuses. It was found that a considerable number of white rats would survive doses of roentgen irradiation given along the paravertebral gutters. The factors were as follows:

¹ From the Robinette Foundation, the Medical Clinic, the Department of Radiology, and the Pepper Laboratory of the Hospital of the University of Pennsylvania.

Voltage, 165 K V. The machine is a Kelley-Koett transformer with a single LaTour circuit with a ripple current, the ripple being from 8 to 12 per cent at 15 milliamperes.

No 3, Pb_3O_4 , No 4, HgS No 6 is a tracing of the particles subsequent to a crushing of fifteen minutes' duration and shows that these but slightly exceed in size the diameter of an erythrocyte (No 5)

The crushing must be done much more thoroughly if the lymphatic system is to be injected, particularly so in case of a parenchymatous injection, and may require as long as from two to three hours. After similar crushing the particles of the substance are of very small diameter ($3-5\mu$) and readily penetrate in the intracellular spaces. A thoroughly prepared substance insures a successful injection and a demonstrative section.

The injection requires no special devices and is performed by means of an ordinary Record syringe with a fine needle. In injecting the subcutaneous lymphatic vessels in man (Figs 3, 4) or animals (Fig 9) the procedure is begun by inserting the needle into the skin of the finger or toe in the region of the ungual phalanx on the surface of the flexor. Later after a large subcutaneous lymphatic vessel has been revealed the needle may be introduced into the latter and the injection continued until the vessels reaching as far as the nearest regional lymphatic glands (*i.e.*, either popliteal or ulnar) are filled with the substance. In case the vessels retain the contrasting substance (Fig 8) it is possible to continue the injection by inserting the needle into the gland itself (Fig 9) and in this way obtain the contrasted contour of the vessel in its further course.

The thoracic duct is successfully injected by inserting the needle into the inguinal lymphatic glands (Fig 5).

With the purpose of performing a

complex topographic injection of several vascular systems (either of two or of three, namely, the arterial, the venous, and the lymphatic (Figs 6, 10), it suffices to substitute the essential contrasting substance for the subsequent injection with one of a greater or smaller atomic weight, as it is the latter property that determines the contrasting capacity. White lead ($2PbCO_3 \cdot PbOH_2$) = 774.7, red lead (Pb_3O_4) = 684.7, cinnabar (HgS) = 232.06.

Due to the fact that substances of the nature of an emulsion cannot be satisfactorily used for injecting the lymphatic system in living animals, we have tested for the purpose a series of both simple and colloidal solutions (salts of bromine, strontium, lipiodol) and the best results were obtained by the application of a 30 per cent solution of collargol. In this case as well, the solution is injected by means of an ordinary Record syringe, either subcutaneously or intramuscularly or into the arthral cavity of a slightly anesthetized animal, and then the roentgenogram is made (Figs 11 and 12).

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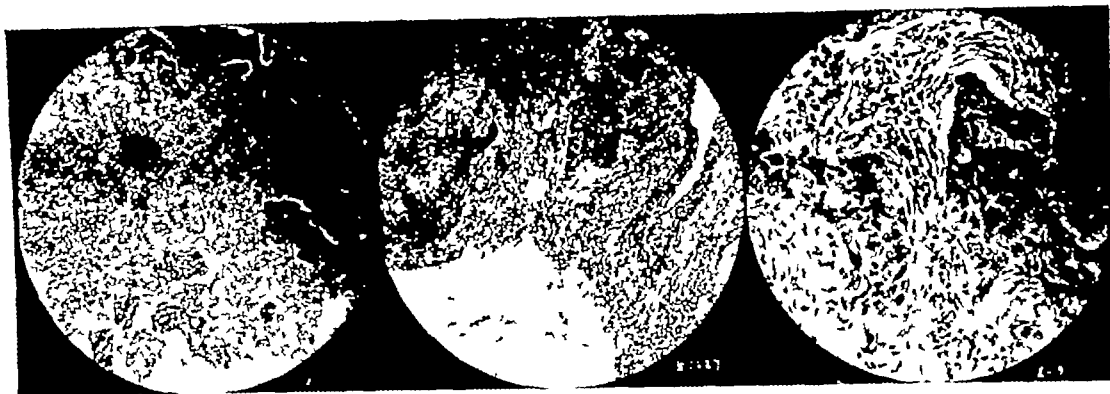


Fig 1 Photomicrograph of specimen removed from right main bronchus, showing general invasion of squamous-cell carcinoma into the deeper structures of the bronchus Magnification $\times 75$

Fig 2 Photomicrograph of specimen removed from right main bronchus, showing typical squamous-cell carcinoma with tendency to pearl formation Magnification $\times 150$

Fig 3 Photomicrograph of specimen removed from right main bronchus, showing more detailed structure of squamous-cell carcinoma Magnification $\times 300$

is not, of course, so readily obtained in cases in which radiation is used instead of the surgical removal of the growth. This author was unaware, or chose to ignore, that nearly as many cases of biopsied lung carcinoma treated by radiation are now living and free from symptoms, as those treated by surgery, which he enumerated as quoted above. Kernan, in April, 1933, reported a biopsy made on the lung of a 17-year old girl, April 26, 1927, which the pathologist designated as "malignant tumor, probably carcinoma," and graded IV on Broders' scale. Immediately thereafter the patient received a course of high voltage roentgen treatments. "From then until the time of writing this article, she has been perfectly well, with no more bleeding and no pulmonary symptoms. Roentgenograms of her lungs, however, still show the same [tumor] shadow."

Including this case, Kernan observed nine patients suffering from histologically proved carcinoma of the bronchi or lungs who had been treated by x-ray, radium, and diathermy, although the last was not employed in all the cases. At the time his report was made, three were dead (33 per cent), four were well without any clinical symptoms or roentgenologic findings (44 per cent), and two were alive and well but still had suspicious shadows in the

chest (22 per cent). All the patients had survived from three to five years since the conclusion of treatment.

In the series reported by Leddy and Vinson there were 42 histologically proved cases of bronchogenic carcinoma, treated by radium or roentgen rays. Ten of these patients, who received roentgen therapy alone, were living from fifteen months to four years after the diagnosis was made, the average duration of life for the entire group being twenty-three months.

Roberts, though presenting no cures, considers that x-ray treatment is justified in all cases too far advanced to be treated otherwise, because it is the best method of relieving severe pain and cough, even if life is not much prolonged. In his cases there was evidence of alleviation, re-expansion of the collapsed lung, and even temporary regression of the tumor.

In comparing the results obtained by surgery and those by radiation, we must not forget that surgery carries with it a primary hazard which is not connected with any form of irradiation. The figures for lobectomy done for benign conditions are interesting in this connection. Roberts and Nelson report two dead out of 10 lobectomized, or 20 per cent. Of Janes' 16 cases, five died—a 30 per cent mortality. As both of these reports concern

RADIATION THERAPY IN CARCINOMA OF THE BRONCHUS

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From the Radiation Therapy Department, Beth Israel Hospital I. SETH HIRSCH, M.D.,
Director

IN preparing a report of the case of carcinoma of the bronchus here recorded, the present writer made a careful survey of recent literature upon the general subject of lung carcinoma. While he found abundant material, very little of this concerned therapy, and of the reports of treatment only few even mentioned other means than surgery. There was a very general agreement among all authors upon certain points, notably

1 Carcinoma of the lung is not a very frequent type of the disease, but its incidence appears to be increasing.

2 The onset is insidious, it probably exists in an active state for a considerable time before any clinical symptoms are manifested, or any shadows evident on x-ray examination.

3 The diagnosis of primary carcinoma of the lung in its early stages is rarely (if ever) made, because of the insidious character of its onset.

4 The great majority of authors recommend surgery as the only possible means of treatment, although very few of them hold out any hope of surgical cure, or even relief, and those who report surgical cases admit a mortality never less than 50 per cent, and frequently much higher.

5 Most authors mention radiation therapy only to condemn it, but in three articles (those by Leddy and Vinson, Roberts, and Kernan), radiation is recommended, and case reports of its favorable use are included.

As the details of histology, pathogenesis, and clinical picture have been very fully discussed in the papers cited above, they will not be touched upon in connection with this report, the present discussion being entirely confined to treatment. To quote Allen and Smith: "The treatment to be recommended depends, of course,

upon the extent of the growth at the time the definite diagnosis is made"—thus in view of the universal agreement that diagnosis is never made until the lesion is far advanced. These same authors advocate a lobectomy "for tumors located well out in the periphery or midportion of a lobe," but add that, as Graham has already pointed out "the radical operation offers scant hope of cure at present because of the advanced stage at which the diagnosis is usually made." By direct reference to Graham's paper, I find he states that, "In all, there are apparently six cases in the literature in which a patient has survived for at least a year the surgical removal of the [lung] carcinoma. Two of these patients were operated on by Sauerbruch, one by Churchill, two by Edwards, and one by Allen and Smith. At the time of the publication of these respective reports one of these patients was still alive and well five years after operation, another one three years, and two for two years. In most of these cases one lobe of the lung was removed." This paper was published in February, 1934, and is the most recent on the subject of lung carcinoma I have been able to find.

In Graham's paper is a considerable discussion of the claims of radiotherapy as a treatment for carcinoma of the lung. He asserts "It is a matter of the utmost importance that the question should be definitely settled whether or not treatment by either the roentgen ray or by radium has ever cured a single proved case of a primary carcinoma of the bronchus or lung." reports of the treatment of cases by this means should be made in such a way as to make the evidence incontrovertible." By "incontrovertible evidence" this author no doubt means a definite biopsy report of primary carcinoma, which

base of the upper right lobe, with slight pleural reaction. Roentgenogram suggests a primary bronchial carcinoma springing from the root of the right lung and invading a portion of the upper right lobe, without completely obstructing the bronchus.

Laboratory Findings were as follows

Urine	Normal	Feb 9,	May 5,	Dec 11,
Blood		'33	'33	'33
Red cells		4,100,000	5,480,000	5,230,000
Hemoglobin		85%	100%	100%
White cells		8,300	5,800	5,600
Polymorphonuclears		73	82	76
Mononuclears		27	18	24
Abnormal forms		0	0	0
Sedimentation rate—50 mm (Feb 9 1933)				
Venous pressure—3 cm (Feb 9, 1933)				
Wassermann reaction—Negative				

Bronchoscopic Examination—(Dr G W Miller) The mucous membrane of the right main bronchus is markedly congested. Underlying cartilaginous rings not transparent, hypertrophy especially noticeable in the lumen of the upper lobe bronchus. Specimen obtained for biopsy.

Biopsy—Squamous-cell carcinoma of bronchus.

Treatment—Roentgentherapy (protracted fractional irradiation) with the following set-up: Constant potential, valve-tube rectification, 200K V, 4 ma, filtration, 2 mm Cu and 1 mm Al, distance, 60 cm.

The basic principle of treatment was to administer maximum irradiation to the tumor mass by cross-firing through three portals of entry, as well as by irradiation of the mediastinum and hilar glands. A regular daily treatment was given so long as the patient remained in the hospital. It was felt that the success of the therapy depended upon the high dosage and protracted fractional administration. Treatments were given as follows:

	Portal	Time total	Dose total
Feb 21 to March 7 1933 (13 tr) rt ant thoracic portal	11×13	585 min	3744 r (288 r/day)
March 28 to April 12, 1933 (10 tr) rt lat thoracic portal	12×14	420 min	2688 r (268 r/day)
April 13 to May 8, 1933 (12 tr) rt post thoracic portal	14×18	560 min	3584 r (298 r/day)
Total			10,016 r

It was also planned at the outset to give radiothermy treatments three times

weekly, following the x-ray therapy. This was an attempt to increase the metabolism of the tumor, and perhaps influence the radiosensitivity of the malignant tissues. Nine such treatments were accordingly given between Feb 27 and May 10, 1933, the resulting fever usually lasting seven hours. The maximum rectal temperature induced was approximately 103° F.

Progress—Examination of the chest, one month after the institution of x-ray therapy, showed considerable reduction in the size of the tumor at the root of the right lung. A bronchoscopic examination two weeks previously—twelve days after treatment was begun—though reporting the upper right lobe bronchus narrowed, its mucosa infiltrated, and its carina reduced in diameter, nevertheless gave "an appreciable improvement over the previous findings."

Dose—Each of three portals used received a maximum skin-toleration dose, producing erythema and pigmentation. May 1, 1933, x-ray examination showed no bronchostenosis and marked regression of the tumor mass, although infiltration was still evident at the root of the right lung, extending outward along the interlobar fissure, with moderate bilateral lymph node enlargement at the roots of the lungs.

Clinically there was no cough, no thoracic pain, and no blood-tinged sputum. The patient had gained ten pounds in weight, which was 195 pounds on May 1, 1933. Blood examination showed an increase in red cells and hemoglobin, and a decrease in leukocytes. The patient left the hospital and went to work.

Re-examined Aug 3, 1933, the x-ray showed scarcely any evidence of infiltration at the base of the upper right lobe, though there was still thickening of the

bronchial walls in this area. The weight was 196 pounds, and the general condition

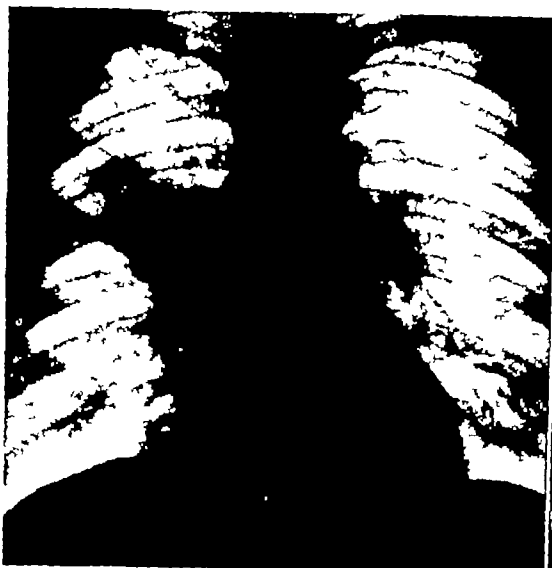


Fig 4 Primary bronchial carcinoma taken Feb 10, 1933, before x ray treatment was instituted. There is present a localized atelectasis the bronchial obstruction is not complete. The tumor appears to spring from the root of the right lung and is invading the basal portion of the right upper lobe.

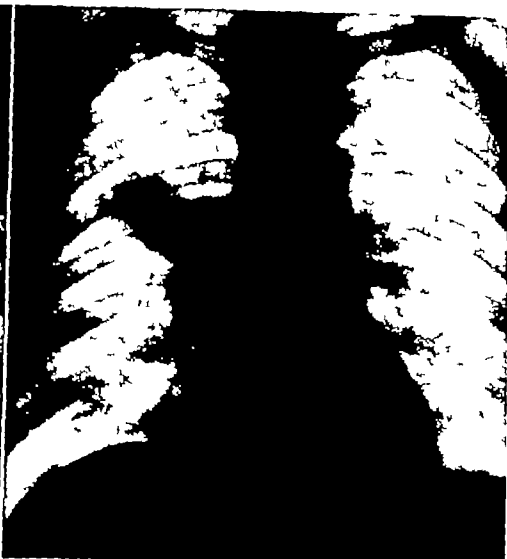


Fig 5 Primary bronchial carcinoma taken March 3, 1933 early in the course of x ray treatment. There is present an incomplete bronchial obstruction the localized atelectasis is diminished. The tumor appears to be more circumscribed and shows considerable reduction in size.

benign conditions only (bronchiectasis), the question of metastasis by the dissemination of cancer implants did not have to be considered, as it must be when a malignant growth is removed by lobectomy.

The following case is presented as offering "incontrovertible evidence" of complete regression of a proved carcinoma primary to a bronchus, after roentgen therapy alone, the patient being symptom-free for twelve months after treatment was administered.

Carcinoma Primary to a Bronchus, Treated by Prolonged Fractional Irradiation—S M, male, aged 52 years, referred to the Radiologic Service, Beth Israel Hospital, Feb 20, 1933. By occupation a teamster, he also worked in a junk shop, moderate user of alcohol and tobacco. Pneumonia (?) four years ago, personal and family history otherwise negative.

Seven months before entrance, the patient had a cold which left him with a chronic cough, producing a thick, yellowish phlegm. Five weeks before entrance he

was awakened from sleep by a sharp, "clutching" pain in the right anterior chest. At this time the pain lasted but a few seconds, but a week later it recurred, and though less severe, lasted for several hours. Twenty-four hours prior to admission the expectoration had become blood-stained.

In the general physical examination the thoracic findings were as follows: *Heart*—No shift nor cardiac dullness, apex in the fifth interspace. No murmurs, sounds of good quality. A₂ greater than P₂, rate, 84, blood pressure 120/90. *Lungs*—Left lung normal. Over right lung, upper lobe posteriorly, there are diminished resonance and breath sounds, anteriorly, the breath sounds are markedly diminished. Anteriorly, over areas of dullness there is increased transmission of the spoken voice. *Impression*—Partial atelectasis of upper right lobe, probably due to a neoplasm, with partial bronchostenosis.

Roentgenologic Examination—Distortion of the shadow of the upper right hilum, associated with atelectatic changes in the

base of the upper right lobe, with slight pleural reaction. Roentgenogram suggests a primary bronchial carcinoma springing from the root of the right lung and invading a portion of the upper right lobe, without completely obstructing the bronchus.

Laboratory Findings were as follows

Urine	Normal			
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Bronchoscopic Examination—(Dr G W Miller) The mucous membrane of the right main bronchus is markedly congested. Underlying cartilaginous rings not transparent, hypertrophy especially noticeable in the lumen of the upper lobe bronchus. Specimen obtained for biopsy.

Biopsy—Squamous-cell carcinoma of bronchus.

Treatment—Roentgentherapy (protracted fractional irradiation) with the following set-up: Constant potential, valve-tube rectification, 200K V, 4 ma, filtration, 2 mm Cu and 1 mm Al, distance, 60 cm.

The basic principle of treatment was to administer maximum irradiation to the tumor mass by cross-firing through three portals of entry, as well as by irradiation of the mediastinum and hilar glands. A regular daily treatment was given so long as the patient remained in the hospital. It was felt that the success of the therapy depended upon the high dosage and protracted fractional administration. Treatments were given as follows:

	Portal	Time total	Dose total
Feb 21 to March 7 1933 (13 tr) rt ant thoracic portal	11×13	585 min	3744 r (288 r/day)
March 28 to April 12, 1933 (10 tr) rt lat thoracic portal	12×14	420 min	2688 r (268 r/day)
April 13 to May 5, 1933 (12 tr) rt post thoracic portal	14×18	560 min	3584 r (298 r/day)
Total			10,016 r

It was also planned at the outset to give radiotherapy treatments three times

weekly, following the x-ray therapy. This was an attempt to increase the metabolism of the tumor, and perhaps influence the radiosensitivity of the malignant tissues. Nine such treatments were accordingly given between Feb 27 and May 10, 1933, the resulting fever usually lasting seven hours. The maximum rectal temperature induced was approximately 103° F.

Progress—Examination of the chest, one month after the institution of x-ray therapy, showed considerable reduction in the size of the tumor at the root of the right lung. A bronchoscopic examination two weeks previously—twelve days after treatment was begun—though reporting the upper right lobe bronchus narrowed, its mucosa infiltrated, and its carina reduced in diameter, nevertheless gave "an appreciable improvement over the previous findings."

Dose—Each of three portals used received a maximum skin-toleration dose, producing erythema and pigmentation. May 1, 1933, x-ray examination showed no bronchostenosis and marked regression of the tumor mass, although infiltration was still evident at the root of the right lung, extending outward along the interlobar fissure, with moderate bilateral lymph node enlargement at the roots of the lungs.

Clinically there was no cough, no thoracic pain, and no blood-tinged sputum. The patient had gained ten pounds in weight, which was 195 pounds on May 1, 1933. Blood examination showed an increase in red cells and hemoglobin, and a decrease in leukocytes. The patient left the hospital and went to work.

Re-examined Aug 3, 1933, the x-ray showed scarcely any evidence of infiltration at the base of the upper right lobe, though there was still thickening of the

bronchial walls in this area. The weight was 196 pounds, and the general condition



Fig 6 Primary bronchial carcinoma taken May 1, 1933 at the end of the x-ray treatment of the right thorax. There is marked regression of the tumor mass, no bronchostenosis, area of atelectasis diminished.



Fig 7 Primary bronchial carcinoma taken Feb 21, 1934, one year after beginning of the x-ray treatment. There is a complete disappearance of the tumor, no atelectasis and no bronchostenosis. There is some thickening of the bronchial walls of the primary and secondary root branches in the right upper lobe.

excellent. Further examination Dec 8, 1933, showed no atelectasis, and considerable resolution of the carcinomatous infiltration, though some thickening of the bronchial walls was still in evidence. There was no metastasis in the left lung, or elsewhere, weight was 193 pounds.

Present Condition—When seen Feb 28, 1934, just before this paper was begun, the patient appeared in perfect health and absolutely symptom-free. His weight was 205 pounds. The x-ray inspection at this time showed the following: almost complete regression of the lesion at the root of right lung, hilum shadow very slightly distorted, particularly in upper part, small area of infiltration at third intercostal space, neither very dense nor sharply defined. "It is justifiable to deduce from these films that the major portion of the tumor has completely disappeared, and there now remains only some productive changes in the bronchial walls." When seen again on May 1, 1934, the patient was symptom-free and in excellent condition.

SUMMARY AND CONCLUSIONS

In the extensive literature now existing concerning carcinoma of the lung, most of the authors name surgery (lobectomy) as the treatment of choice. This choice is limited, however, by the opinion universally expressed, that only comparatively early cases are suited for lobectomy, and that the insidious nature of lung carcinoma makes early diagnosis practically impossible. Comparison of statistics also shows that lobectomy, when done for benign conditions, carries with it a high mortality (from 20 to 30 per cent).

Radiation by roentgen ray and radium has no immediate mortality. Many writers mention that even if life is not prolonged by radiation therapy, the patient's sufferings are greatly lessened, and what life remains to him is made more endurable. A number of isolated cases have been reported in which the progress of histologically proved primary carcinoma of the lung has been halted by radiation,

the patient remaining in good condition for some months—too short a time to permit any claims of permanent cure. Leddy and Vinson report 10 patients who, after having received roentgen therapy alone, are living and well from fifteen months to four years after the diagnosis. Kernan reports four patients without any evidence of carcinoma, and two clinically well but showing some remains of the lung tumor roentgenographically. As these represented 25 per cent of the first series and 66 per cent of the second, these results are certainly equal to those of surgery.

There would seem to be justification for the conclusion that irradiation is to be preferred in the treatment of lung carcinoma, as it offers greater possibility of cure in the early cases, for the following two reasons: (1) the indications for its use are much less restricted than those of surgery, (2) in advanced cases, beyond hope of cure by any means, it affords a far greater degree of palliation than can be otherwise obtained.

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THE TREATMENT OF CANCER OF THE MOUTH BY SURFACE AND INTERSTITIAL IRRADIATION¹

By GEORGE E. PFAHLER, M.D., Sc.D., Professor of Radiology,
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AS is well known by all of you, we can lay down general principles as to the treatment of cancer of the mouth, but the individual who has cancer must be treated according to conditions present. A technic must be used which will destroy or remove all of the cancer and yet avoid as much as possible damage or destruction to the other tissues. To fulfill these requirements, it is unwise to be limited to any one special technic. At times, it is advisable to combine local surface applications of radium with external applications by radium packs, or with the more penetrating highly filtered roentgen rays. In those cases which are of long duration or in which there is much fibrous scar tissue, perhaps from incomplete treatment, it is often advisable to remove the remaining local disease by electrocoagulation.

As a general rule, it is my custom to begin the treatment of cancer of the mouth with radium packs or high voltage x-rays applied externally so as to control at the beginning the spread of the disease. This is followed almost immediately, however, by local surface applications of radium inside the mouth. These applications are applied usually on alternating days inside the mouth and externally, so that the patient does not become too much disturbed by one form of treatment. For the local applications, we use radium element covered by 2 millimeters of platinum, covered with 1 millimeter of rubber filtration for the applications within small crevices, but where space permits, this is increased by 2 millimeters of rubber, giving 5 millimeters in distance. The applications are made successively on all sides of

the tumor area, so that all parts of the tumor tissue shall receive from six to ten erythema doses, counting the external irradiation.

The radium is applied in all possible positions to obtain a cross-firing effect on the primary lesion. For example, with a lesion on the posterior portion of the tongue, radium is applied to the base of the tongue, dorsum of the tongue, and in the floor of the mouth. Lesions in the anterior portion and margins of the tongue are irradiated by radium applications on the dorsum of the tongue and in the floor of the mouth. These surface applications are frequently supplemented by interstitial irradiation with platinum needles containing one, two, or three milligrams of radium element, and inserted preferably through the skin so as to avoid infection, and so distributed as to give uniform irradiation through the tumor area.

To make the local applications of radium for surface effects we use lead applicators 3 millimeters thick, which shield the surrounding tissues. These lead applicators can be adapted to every particular location and lesion, and must be prepared especially for each individual case, or each individual lesion.

For applications in the pharynx and about the posterior surface of the tongue, we use hollow tubes containing radium capsules which can be shaped to the curve of the pharynx.

We have not found the dental molds very satisfactory because they occupy too much space, and in our patients the cancer often interferes too much to allow opening the mouth sufficiently to introduce such dental molds. Furthermore, we have found that the dental compound does not give as much protection to the normal tissues in proportion to its thickness as does lead

¹ Discussion before the Fourth International Congress of Radiology at Zürich, Switzerland, July 23-27, 1934.

The lead applicators which we use are covered with a layer of 1 mm of rubber

In all cancers of the mouth we give our chief attention to the associated lymphatics. The local disease, if necessary, can be removed by electrocoagulation or, if conditions interfere with sufficient irradiation, by surface application, then interstitial irradiation can be used.

For *interstitial irradiation* we use radium element in needles containing one, two, three, and ten milligrams, each milligram being distributed in approximately two centimeters of needle length. The 3-milligram radium needles are 6 centimeters in length, and the wall thickness is 0.6 mm of irridio-platinum. The 1-milligram and 2-milligram needles are covered with 0.5 mm of irridio-platinum. The small quantity radium needles are used for prolonged irradiation, usually remaining in place about five days. I say five days instead of seven or eight days because we give in association surface irradiation, both inside the mouth and externally. The 10-milligram radium needles are made of monel metal, and have walls of 0.4 mm in thickness. These are used when for some reason the smaller quantities cannot be used for a long period of time. I prefer the slowly and highly filtered irradiation, but, in certain cases, one must obtain the necessary irradiation effects in a short period of time. The 10-milligram radium needles are used particularly when we do electrocoagulation, and they are then inserted into the wound immediately and directed outward from the site of the former disease. These are usually left in place only four hours, and are placed approximately one centimeter apart. All local irradiation is supplemented by radium packs or high voltage roentgen rays.

Radium packs are made up with Columbia paste, or one may use felt pads or sponge rubber. We use from four to six centimeters distance. The units of 10 milligrams of radium element each are contained in 1 millimeter of gold and 1 millimeter of platinum, which is the equivalent of 4 millimeters of lead. From

clinical observation I am convinced that a higher filtration gives a proportionately greater differentiation effect on the malignant tissue as compared with the normal tissue. In other words, I obtain a more satisfactory destruction of the malignant tissue and a better preservation of the normal tissues. The units are used in a proportion of about one milligram to each square centimeter and so arranged as to give a uniform irradiation to all parts of the tumor tissue. We commonly use 150 milligrams on the affected side, and 100 milligrams on the opposite side. These packs are left in place twenty-four hours, and are repeated two or three times a week until from 30,000 to 50,000 milligram-hours are used during from three to four weeks. This external radium treatment is supplemented by local applications of surface or interstitial applications of radium, and when necessary, by 200 K V roentgen irradiation, filtered through 2 millimeters of copper. Further details on technic are given in a recent communication.²

In the treatment of carcinoma of the lip we commonly destroy or remove the lesion by electrocoagulation and supplement this with high voltage irradiation over the lymphatic glands draining the area. When the lesion is large, so that one cannot accomplish this result without destroying the functions of the lip, then we attempt to control the disease of the lip by interstitial and surface applications or radium. However, in the small lesions, it is advisable to obtain a biopsy, and therefore, since there must be some traumatism for the purpose of taking a biopsy, I have concluded that it is better to remove the entire lesion, providing it will not cause too much deformity of the lip. In the early lesions, it causes practically no deformity. The results of treatment by the above technic are shown in the accompanying tables, which have been prepared for me by my associate, Dr. Jacob H. Vastine.

² Irradiation Therapy in Cancer of the Mouth Technic and Results, G. E. Pfahler and J. H. Vastine, RADIOLOGY, January, 1934, 22, 15-26.

TABLE I—RESULTS IN 316 CASES OF EPITHELIOMA OF THE LIP

Treatment carried to a conclusion	294
Advanced and hopeless cases in which treatment was not advised	22
Total	316

CLASSIFICATION ACCORDING TO RESULTS OF TREATMENT

	Cases	Percent
Living and free from evidence of disease (absolute cures all cases)	240	= 81
Dead from carcinoma	40	= 13
Well when last seen—not traceable now	14	= 6
Total	294	= 100
Omitting the 14 cases not traceable—but probably well	Recovery—85%	Dead—15%

CLASSIFICATION ACCORDING TO EXTENT OF DISEASE

	Recoveries	Dead from cancer	Total
Local lesion, 1.5 cm or less in diameter	159—98%	3—2%	162
Local lesion, extensive, i.e., more than 1.5 cm in diam	53—79%	14—21%	67
Cases in which there were palpable lymph nodes	25—53%	22—47%	47
Post-operative irradiation given before recur	3—75%	1—25%	4
Total	240	40	280
Cases with no palpable lymph nodes	212—92%	17—8%	229
Cases with palpable lymph nodes	25—53%	22—47%	47

CASES TREATED PRIOR TO JANUARY 1, 1929

	Well	Per cent well over 5 years	Dead from cancer	Lip well* dead from inter dis	Not traced	Total
Local lesions less than 1.5 cm diam	107	97.2%	3	13	4	127
Ext lesion more than 1.5 cm diam	25	75.7%	8	9	2	44
Cases with palpable lymph nodes	7	26.8%	19	4	1	31
Grand total						202

* Not included in percentages

TABLE II

Total treated by previous methods	181
Total treated by present technic	264
Total mouth cases treated	445
Total lip cases treated	294
Grand total	739

TREATED BY PREVIOUS METHODS

	Well	Per cent absolute 5-year recoveries	Dead from cancer	Dead from intercurrent disease	Not traceable
Tongue	27	28.5%	53	4	11
Cheek	9	28.1%	20	2	1
Tonsil	5	35.7%	8	0	1
Lower jaw	1	5.3%	13	2	3
Palate and pharynx	2	9.5%	13	1	5
Total	44	24.3%	107	9	21

TREATED BY PRESENT TECHNIC

	Well		Less than	Per cent	Per cent	Dead	Dead	
	5 yrs	3 yrs	3 years	absolute	absolute	from	from	Not
				5-year	3 year	cancer	inter	traced
				recoveries	recoveries		disease	
Tongue	16	5	6	26 2%	25 0%	76	1	2
Cheek	7	10	5	35 0%	44 7%	16	3	3
Tonsil	2	2	6	20 0%	22 2%	14	0	3
Lower jaw	6	3	2	25 0%	27 5%	22	4	2
Palate and pharynx	9	6	3	30 0%	35 7%	25	4	1
Total	40	26	22 = 88	27 6%	30 6%	153	12	11

Excluding cases which could not be traced and which died of intercurrent disease, there were 30.7 per cent of 5-year recoveries by present technic, 33.8 per cent of 3-year recoveries by present technic.

The list of 5-year recoveries refers only to those cases which were treated more than five years ago, the 3 year recoveries refer only to those treated more than three years ago, and the others refer to those treated less than three years ago

TABLE III —MOUTH CASES WITH PALPABLE LYMPH NODES

Of 211 cases, 45 (21.3 per cent) well for varying periods
Of 77 cases, treated prior to 1924 (old technic), 13 (or 16.8 per cent) are 5-year recoveries
Of 55 cases, treated between 1924 and 1929 (newer technic) 15 (or 27.2 per cent) are 5-year recoveries
Enlarged nodes in and about which radium needles were inserted for from 4 to 7 days = 24 cases, of which 10 are living and apparently well for periods of from
less than 1 year, 1 case,
1 to 2 years, 3 cases,
2 to 3 years 3 cases,
3 to 4 years 3 cases

PRESENT METHODS OF TREATING NECK METASTASES BY RADIATION AT THE STATE INSTITUTE FOR THE STUDY OF MALIGNANT DISEASES AT BUFFALO, NEW YORK¹

By BURTON T SIMPSON, M D , Director

THE State Institute was founded primarily for the purpose of research concerning the causes and the treatment of cancer and allied diseases. At the present time our therapeutic researches are chiefly concentrated on the radiation treatment of cancer to determine if possible, the exact rôle that irradiation plays in the treatment of this group of diseases. While we do not wish to enter into any controversy in regard to the relative merits of surgery, it is our opinion, based upon our observations, that in most cases radiation is the preferable method of treatment for metastatic deposits in the neck.

For treatment purposes we have at our disposal 7,770 milligrams of radium, distributed approximately as follows: four grams in a large pack, two grams in solution, ten tubes each containing 100 milligrams and seven tubes each containing 50 milligrams of radium salt, 165 cells each containing from 1 to 5 milligrams, which when placed in platinum needles may be utilized for implantation. We have also three x-ray machines of 200 K V capacity at 25 milliamperes.

The personnel consists of a surgeon, a radiotherapist, a physicist, and a pathologist, supplemented by other specialists interested in cancer therapy.

Our methods of radiation treatment have naturally been modified from time to time to meet the advances made in this type of therapy and also in accordance with our experiences. In the early days, large single doses were the rule. However, when it was found that more radiation could be introduced into the lesion by the divided dose method without injury to the skin, the single dose method was discarded and divided dosage introduced. Filtration experiments were carried on by our physicists

and advancement was made along these lines. Many cases were treated by implantation of radon and needles containing radium salt, either alone or combined with external radiation.

It would be useless to go into detail concerning the methods formerly used. I should like, however, to describe a few cases, illustrating each of our methods of treatment of metastatic nodes in the neck.

IMPLANTATION (GOLD SEEDS OF RADON)

The first case, a male patient aged 68 years, had a squamous-cell carcinoma of the floor of the mouth, associated with a metastatic node in the right submaxillary region. Both the primary lesion and the metastasis were treated by implantation with gold seeds containing radon. The node received a total of 660 millicurie-hours. The primary lesion healed and the node disappeared. The patient has remained free from any clinical evidence of the disease up to the present, a period of more than six years. While we had no biopsy of this node, we were quite certain from the clinical findings that it was a true metastasis.

Notwithstanding the favorable outcome of the case cited, we have largely discarded the practice of implantation of metastatic nodes and use this procedure only in exceptional cases, for we believe that equally good results can be obtained by external radiation and thus avoid some of the undesirable effects of implantation.

EXTERNAL RADIATION—X-RAY

The patient, a male aged 73 years, presented a group of hard, sharply defined nodes in the peritonsillar region extending down the sternomastoid muscle, on the left side of the neck. Biopsy showed squamous-cell carcinoma. The patient was

¹ Presented before the Fourth International Congress of Radiology, at Zurich, Switzerland, July 24-31, 1934.

given eight daily treatments on the left side of the neck over a field 10×15 cm at a distance of 50 cm target-skin distance. The factors were 200 K V, 30 milliamperes, with 0.5 mm copper. The lambda effective was 0.16 Å. Calculation showed 277 r per dose, thus making a total of 2,220 r on the skin and a cumulative dose of 1,600 r, allowing a loss of radiation effect of 8 per cent per day. Two months after this treatment there was a complete disappearance of the metastatic nodes. Unfortunately, after a period of several months, there was recurrence in the radiated nodes and evident involvement of the nodes on the opposite side.

Experiences of this character convinced us that the effective dosage was insufficient and also that it was desirable to treat both sides of the neck, notwithstanding the fact that there were no perceptible nodes on one side. As a matter of fact, we are at present radiating both sides of the neck in all malignant lesions of the lip, tongue, mouth, pharynx, or larynx, whether or not there is evidence of metastatic involvement.

The following case history illustrates the type of treatment which we believe is more effective and will produce better results. It is the type of x-ray therapy which we are using at the present time.

The patient, a female aged 74 years, showed a metastatic node 3 cm in diameter in the left submaxillary region following a surgical removal of a primary carcinoma of the larynx eight months previously. The treatment factors were as follows: 200 K V, 30 milliamperes, with Thoreaus filter, the equivalent of 3 mm copper. The field was 10×15 cm at a distance of 50 centimeters. The left side of the neck was given ten consecutive daily doses, followed directly by four consecutive daily doses on the right side of the neck. With the Thoreaus filter the lambda effective is measured as 0.11 Å. The estimated daily dosage was 340 r, making a total of 4,100 r on the skin with a cumulative dosage peak of 2,340 r, allowing an 8 per cent loss of radiation effect for this wave length. There was marked dimi-

nution in the size of the node following treatment.

The period of time which has elapsed since we have adopted this method of treatment is too short to allow us to present clinical results.

RADIUM

For external radiation with radium we utilize either the "small" two-gram pack or the "large" four-gram pack.

Two-gram Pack—The two-gram pack contains the equivalent of 2 grams of radium consisting of a combination of radium salt and radon, usually 1 gram of the element supplemented by a sufficient quantity of radon.

The primary filter consists of 1 mm of platinum, 1 mm of bakelite, with a secondary filter next to the skin composed of 1 mm of copper and 1 mm of aluminum. At 6 cm distance this pack delivers 134 r per gram-hour, and at 10 cm distance, 71.5 r per gram-hour.

The two-gram pack in split doses of 3,000 mg-hrs per day at 6 cm distance for twelve succeeding days has caused the disappearance of metastatic nodes from intra-oral cancer. A marked epidermolytic reaction is necessary in all cases.

A typical case illustrating our technic with the two-gram pack is that of a male patient aged 66 years, with a squamous-cell carcinoma on the floor of the mouth. There was a large fixed metastatic growth measuring 4 cm in diameter located in the left submaxillary region. The primary lesion was treated by implantation of radon seeds, and the metastatic growth with the two-gram pack over a field of 5×5 cm at a distance of 6 centimeters. Eleven treatments were given on successive days. The estimated daily dose was 402 r, giving a total dose on the skin of 4,430 r, supplemented by an additional 500 r received from the radon implanted in the primary lesion. This treatment was followed in about fifteen days by a marked epidermolytic effect on the skin, which subsided in seven weeks. Eight weeks after treatment, the primary lesion had

completely healed and the metastatic mass had entirely disappeared

Four-gram Pack—The "large" pack contains 4 grams of radium. The primary filter consists of 1 mm of platinum, 1 mm of bakelite, 1.5 mm of steel, with a secondary filter next to the skin of 0.5 mm of copper and 1 mm of aluminum. At 6 cm distance this pack delivers 86 r per gram-hour as measured with a thimble ionization chamber calibrated in roentgens for x-rays only. At 10 cm distance the amount delivered is 50 r per gram-hour.

Our method of using the four-gram pack in the treatment of metastatic nodes in the neck is illustrated by the following case history. A female, aged 42 years, had a carcinoma of the thyroid gland with marked metastasis in the left side of the neck. She was given 17 consecutive daily treatments over a field of 10×10 cm at 10 cm distance, the total skin dose being 5,100 r. Allowing 4 per cent per day for loss of radiation effect, a cumulative dose of approximately 3,590 r was given. Five months after this treatment the metastatic growth had entirely disappeared.

A review of the literature dealing with results obtained in the treatment of malignant lesions which have already metastasized to the neck, leads us to be very pessimistic in regard to the ultimate outcome to be expected from the methods used in the past. Schreiner (1), in analyzing 309 cases treated at the Institute between 1912 and 1923, found no five-year cures in 53 cases which gave evidence of metastatic involvement of the neck. On the other hand, the same author (2), reporting upon results obtained in the

treatment of cancer of the lip, was able to report 21 per cent absolute five-year healings in 38 cases which showed definite metastases. It is interesting to note that in the analysis of the lip series 20 per cent which were treated only locally at the time, developed metastatic nodes later. One may conjecture whether or not metastases from lip lesions react more favorably than do those from intra-oral cancer.

Utilizing the Thoreaus filter and thereby obtaining a decidedly shorter wave length with consecutive daily divided doses, first on the side farthest from the lesion, continued for eight to ten treatments, and then repeated on the side nearest the lesion, appears to us to be the method of choice at the present time.

We are convinced that a large percentage of lip and intra-oral cancer cases have established metastases which are not demonstrable. Therefore, we believe that all malignant lesions in these locations should have treatment over the lymph-bearing areas based upon the assumption that metastases are present.

The fact that we are able to salvage even a small percentage of these distressing cases should give us encouragement and lead us to hope that with improved technique we shall be able to present better results in the future.

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DIVERTICULUM OF THE DUODENUM¹

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AS there is no symptom-complex by which a duodenal diverticulum can be recognized clinically, the clinician is dependent for such a diagnosis upon the roentgen ray. Since the first description of diverticulum of the duodenum, in 1710, by Chomel, only one hundred cases had been reported up to 1910. The condition was discovered prior to the latter date by postmortem, or unexpectedly at laparotomy, and was considered rare. From 1910 to 1915, a great number of cases were reported with roentgen-ray demonstration of these diverticula, and in 1913, Case first called attention to the diagnosis of diverticulum of the duodenum by means of the roentgen ray and the opaque meal. Since that time several cases have been reported in the literature from time to time, and their incidence varies from 0.09 to 7 per cent, depending upon the different sources.

Etiology—Duodenal diverticula have been classified as congenital and acquired and these have been subdivided into the true and false types, the former showing all the layers of the intestine and the latter lacking the muscular layer. In the acquired type, the etiologic factor may be (1) traction from without, as in gall-bladder disease, (2) localized defect in the musculature, with a resulting pouch formation, (3) pressure from partial obstruction below, with resulting pouch formation, and (4) trauma.

Symptomatology—The condition is one which must be differentiated from right upper quadrant abdominal pathology and may closely simulate gall-bladder disease, peptic ulcer, pancreatitis, etc. The most common symptom is that of fullness or

bloating and pain of a more or less variable degree. The pain may be localized in the right upper quadrant of the abdomen or may be present in the epigastrium. The pain has been described as sharp or crampy in character, having its onset from one to two hours after meals and lasting for a period of from one to three hours. It may or may not be associated with nausea and vomiting. Neither the giving of food nor alkalies render relief. The symptoms as a rule are vague and the patient may date his complaint over a period of from two to twenty years.

Diagnosis—The diagnosis is usually made by means of the roentgen ray with the aid of an opaque meal. The demonstration of these diverticula depends upon the appearance of a more or less spherical shadow which can be seen to fill and empty from the duodenum. At times, an air bubble is noted within this shadow. Persistence of the shadow is noted after the stomach and duodenum are empty. The differential diagnosis will call for a distinction from calcified glands, biliary stones, renal stones, perforated gastric or duodenal ulcers, and dilatation of the ampulla of Vater. Repeated fluoroscopic examinations may be necessary to reveal the diverticulum, and the connection between the diverticulum and the duodenal bulb may be seen at such examination. The roentgenologic differentiation of the congenital and acquired type cannot be conclusive. Prolonged retention by the diverticulum favors the possibility of diverticulitis.

CASE REPORTS

Case 1 Patient is a white female, aged 35 years, who presents herself for x-ray examination, giving a history of vague abdominal pain with nausea and a

¹ Published by authority of Dr. Charles M. Griffith, Medical Director, Veterans' Administration, Washington, D. C.

previous history of an appendectomy and cholecystectomy eight months prior to the present examination. She states that "no

and as the opaque meal leaves the stomach it passes normally through the duodenal bulb until the bulb is distended. Then



Fig 1 Case 1 Showing diverticulum of the duodenum

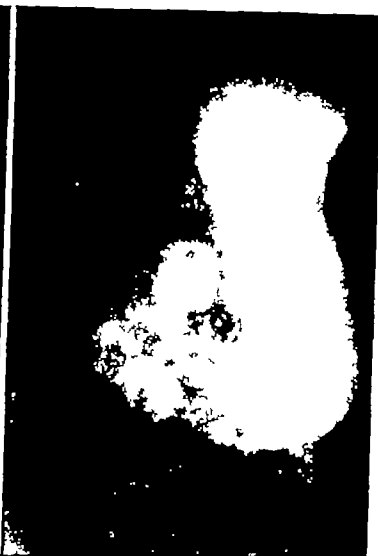


Fig 2 Case 1 Same as Figure 1, with diverticulum being completely filled

improvement has been noted in my general health since the operation and I complain of the same things that I did before I was operated on." At that time, the patient dated her onset of complaint two years prior to the operation, with the chief complaint being distention in the epigastrium associated with a "sour stomach" and pains in the epigastrium which were seldom relieved by the intake of food or alkalis. The symptoms appeared in a cycle with a duration of three or four weeks and a remission of approximately a similar period of time. At times, abstinence from food would offer some relief to the abdominal pain. The general physical examination at this time is negative except for tenderness in the midline of the abdomen in and around the umbilicus, a scar is noted in the right upper quadrant of the abdomen (cholecystectomy).

The x-ray examination reveals no apparent pathology involving the esophagus or stomach. The peristalsis is normal

upon pressure, the examiner forces some of the meal out of the bulb into the second portion of the duodenum and a portion of the meal is noted passing medially from the bulb into a regularly outlined "pocket." The remainder of the gastro-intestinal examination is essentially negative. Fluoroscopic examination at a later date revealed similar findings (Figs 1-3).

X-ray Diagnosis—Duodenal diverticulum. Surgical operation confirmed the x-ray findings and the diverticulum was reported to be situated between the duodenal bulb and the lesser curvature of the stomach (Fig 2). The diverticulum was ligated and removed.

Case 2 Patient is a white male, aged 40 years, who gives a history of an appendectomy at the age of 28 and a herniotomy at the age of 29. He dates the onset of his complaint three years prior to the present examination, with the chief symptom being epigastric pain which comes on one to two hours after meals. This

pain is relieved at times by the intake of food and alkalis. Vomiting is present without nausea and the vomitus contains streaks of blood. No tarry stools have been noticed. The general physical examination is essentially negative except for tenderness in the epigastrium. A scar is noted in the right lower quadrant (appendectomy) and another in the right inguinal region (herniotomy). No masses or fluid are noted in the abdomen.

The x-ray examination reveals no apparent pathology involving the esophagus or stomach. The peristalsis is fairly active. The duodenal cap reveals a filling defect involving the lateral aspect and at the sixth hour a minute amount of barium is seen in the region of the duodenal bulb but apparently outside the normal tract of the duodenum—the head of the meal has reached the mid-point in the transverse colon and the colon is normally outlined up to this point. At the 24-hour examination the ascending colon and the first portion of the transverse colon are empty, while the remainder of the colon is normally outlined.

X-ray Diagnosis—Duodenal ulcer associated with a duodenal diverticulum. Surgical operation revealed a large ulcer with a diverticulum of the duodenum just distal to the pylorus. The operation consisted of resection of the ulcer-bearing portion of the duodenum and distal third of the stomach. The stump of the duodenum was closed and the stomach anastomosed to the jejunum.

SUMMARY

1 The diagnosis of duodenal diverticulum depends chiefly upon the roentgen ray.

2 Two cases are reported in detail. The chief symptoms are fullness and bloating in the epigastrium, associated with a pain in the right upper quadrant of the abdomen or in the epigastrium, a pain which is not necessarily relieved by the intake of food or alkalis.

3 The differential diagnosis involves a consideration of gall-bladder disease, peptic



Fig 3 Case 1. Recheck gastric examination showing retention within the diverticulum described at the end of six hours.

ulcer, pancreatitis, perforated gastric and duodenal ulcer.

Case 1 clearly shows the difficulty which arises in the differential diagnosis of this condition when no x-ray procedure is carried out. Cholecystography makes possible an adequate diagnosis as to gall-bladder pathology and, had the patient had a cholecystogram or a gastro-intestinal examination prior to operation, the operation prior to the removal of the diverticulum (cholecystectomy) could have been avoided.

Case 2 reveals the acquired type of diverticulum.

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A POSSIBLE DEVELOPMENT IN ROENTGEN THERAPY

(TRANSFORMATION OF MERELY TRANSMITTED INTO ABSORBABLE
ROENTGEN ENERGY)

By HANS A. JARRE,¹ M D, and ROBERT F. JAMES,² PH D, *Detroit, Michigan*

RECENTLY Hughes and Binz (1), reported certain experimental observations on the therapeutic use of nascent iodine in irradiation therapy. While their work represents only a preliminary observation, the potential possibilities of enhancing the value of irradiation therapy along the lines presented by the authors is great. We quote as follows:

"The idea was conceived to synthesize an organic, chemically stable iodine compound of low toxicity from which nascent iodine or an active chemical radical could be liberated by roentgen irradiation after its intravenous administration. The purpose was not to produce a compound whose secondary radiations would have a therapeutic value or enhance the value of the irradiation itself. It was proposed rather to obtain a chemically stable pharmacologically inactive compound *per se*, which, under the influence of external forces such as roentgen irradiation, might undergo activation of its chemical structure such as liberation of nascent iodine or an active chemical radical. In this manner it might become possible to control by external forces localized therapeutic effects after parenteral administration of therapeutically inert compounds."

This proposed experimentation should be of considerable interest, particularly if it is possible to liberate sufficient quantities of therapeutically effective but otherwise non-toxic innocuous compounds by the medium of biologically indifferent doses of roentgen energy.

In connection with this article by Hughes and Binz, we feel justified in suggesting thoughts and experimentations along somewhat different lines and certainly at variance with the present trend in roentgen therapy.

At present, there exists a rather dogmatic belief that improvement in radio-

therapeutic results can be obtained only by the further reduction of the wave lengths of the applied energy, or technically speaking, by multiplication of the potentials applied to the roentgen tube plus a heavier filtration. This belief is doubtlessly founded upon the therapeutic benefits obtained by gamma radiation from radium. The attempts to obtain higher voltages on the roentgen tubes are an effort to synthesize the wave lengths of the gamma spectrum of radium. The mechanics are not known by which biologic results are obtained through gamma radiations.

The shorter the wave length of energy in this region of the electromagnetic spectrum, the greater the penetration, or, in other words, the less the total amount of energy absorbed. It is universally accepted that only the absorbed energy enters into a biologic reaction.

There is no question but that gamma radiation does enter into biologic reactions, and that roentgen radiation of wave lengths approaching those of the gamma region must, *per se*, be biologically active. The question resolves into a consideration of efficiency. With an increase of applied potential and consequent decrease of wave length, the percentage of absorbed energy decreases and hence the gross or "overall" efficiency decreases.

As has been previously stated, little or nothing is known on the mechanics of the reaction between gamma radiation and the resulting biologic matter. For this reason it is not possible to compute the efficiency of the absorbed energy in any specific instance. A prediction based on present knowledge may be made with the reservation of rights to change when the fund of information has been increased.

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It is assumed that gamma radiation is generated by nuclear changes in the atoms. Absorption of gamma radiation by nuclear changes in atoms has never been discovered, and consequently the following more logical explanation of this absorption is accepted. It is believed that the waves of gamma radiation strike the electrons in some of the electron shells and thus cause them to generate radiation. This phenomenon is known as "scattering" (plus a repeated Compton effect), and the primary radiation is thus degenerated in successive stages until such a time as the energy is absorbed. During these stages of degeneration the wave length is increased. By logical deduction it would be assumed that at some region of the electromagnetic spectrum there would exist a point of maximum absorption and consequently maximum reaction. This is true both theoretically and experimentally, but the use of radiation from this region presents the practical difficulties of transmission from the source to the desired point of utilization. It is a problem akin to that of finding a container for the universal solvent.

Since "scattering" and eventual absorption do take place, the optimum conditions are those in which the maximum penetration takes place to a certain point with a maximum absorption of biologically effective radiation at that immediate locality.

The desire to obtain such conditions is not new. Attempts have been made to increase radiotherapeutic effects by the introduction of relatively harmless substances to specific localities with subsequent primary irradiation in the hope of generating secondary radiations. A notable attack in this direction is that by Wintz in the iontophoresis of the pelvis with zinc and copper. Undoubtedly there was a time when it was considered feasible to transform short wave high penetration radiant energy into a more readily absorbable form, and this was attempted in the living human being for therapeutic effects.

The idea is still theoretically correct and practically possible.

With the introduction of excretion cholecystography and pyelography we have at our disposal chemical substances of relatively high atomic weight which, when injected intravenously, reach a temporarily high concentration in the liver and kidney, respectively. An attempt would seem justified to utilize the passing concentration of these metallic compounds for effective transformation of short wave length energy into the more efficient but longer wave lengths. The secondary radiation thus generated may prove of sufficient intensity to provide a therapeutic measure in patients with chronic, resistant, renal or hepatic infections and possibly also with malignant neoplasms.

As a means of further concentrating or intensifying these secondary therapeutic radiations it is possible to use an additional agent in the form of a fluorescent substance such as eosine, quinine, mercury derivatives, etc. These materials have fluorescence known to be in the bactericidal regions of the electromagnetic spectrum, these radiations are readily excited.

Confining our suggestions to the iodine compounds since they are more or less in common use, it is interesting to note that the characteristic spectrum of iodine may be excited by wave lengths of above 34 K V. The characteristic spectrum of iodine shows wave lengths of 0.4 and 0.3 Ångstrom units which are in the soft x-ray and Grenz-ray regions and hence readily absorbed by organic materials.

The release of nascent iodine found by Hughes and Binz is due to a photochemical reaction. The combination of a chemical bactericidal agent with a therapeutically active form of radiation is possible, and it is highly probable from the spectral knowledge available that the latter property will materially accelerate and enhance the former.

The fluorescence and secondary radiations of trypanflavin, acroflavin, mercurochrome, fluorescein, quinine, etc., are

excited throughout a wide primary spectral range with intensity peaks depending upon chemical constituency and the quality of the exciting radiation. The combination of the two qualities of radiation plus the possible photochemical effects seems promising in view of the work of Tappeiner and his pupils on oligodynamic effects.

It is to be hoped that the work of Hughes

and Binz will be called to the attention of endowed institutions and those with adequate facilities to continue the work begun by these two physicians.

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THE RATE OF RECUPERATION OF HUMAN SKIN FOLLOWING IRRADIATION¹

PRELIMINARY REPORT

By JAMES J. DUFFY, M.D., Assistant Attending Surgeon, Memorial Hospital,
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HERE are several methods by which external irradiation may be administered. These procedures can be divided into three fundamental types: massive, fractional, and saturation dosage.

By the massive dose method the maximum effect is obtained through the single exposure to radiation. In the fractional dose method the maximum effects are obtained by the gradual administration of small doses. The saturation method consists in maintaining for a certain time a biologic effect already present, by the addition of smaller doses.

In any method the effect upon the normal structures finally limits the amount of radiation that can be delivered, in particular, the effect on the skin is the most important because this structure usually receives the largest amount of irradiation. The skin is an obvious indicator of the degree of damage produced. The gradual fading of the reaction after treatment affords evidence that there is recuperation of the tissues from radiation damage. The rate of recovery in tissues is an important factor in all methods of irradiation. In this type of treatment each quantity of radiation delivered is a sufficient amount to produce an effect equal to that lost by recovery of the tissues over a given time.

A technic for maintaining irradiated tissues in a state of saturation was first described by Kingery (1) in 1920. He assumed that the rate of depreciation in radiation effect was dependent upon the concentration of bio-chemical products. That is, the rate of loss would vary directly as the concentration of some hypothetical

decomposition product. As this concentration decreased, the velocity of loss would become less in direct ratio. This theory draws an analogy from the so-called "mass reactions" of biology and chemistry, which are characterized by a semi-logarithmic curve.

Kingery's clinical observations were conducted upon patients with skin diseases treated by unfiltered rays of a "soft" character. By experimentation he found that an initial 100 per cent erythema dose could be repeated in fourteen days. He further states that 50 per cent of an erythema dose may be added at the expiration of three and one-half days, and 75 per cent at the end of seven days. He illustrated the depreciation of a 100 per cent erythema dose by a semi-logarithmic curve, based upon the above findings.

Pfahler (2, 3) expanded this work, and determined the depreciation curve of radiation effect produced by rays of different quality. He found that "soft" rays produced a biologic effect which depreciated more rapidly than the effect produced by rays of a "hard" quality. Weatherwax (4) continued a similar study, and confirmed the work of Kingery and Pfahler. By employing a formula he also illustrated that elimination of some of the "softer" rays from a given quality of radiation by the use of filters decreased the velocity of loss in radiation effect.

Stenstrom and Mattick (5) made observations upon six cases of breast carcinoma treated by irradiation. The part to be treated was divided into two fields, a single 100 per cent erythema being given to the upper area, and a greater but divided dose being delivered to the lower field. They found that the erythema produced by a single treatment about

¹ Read before the Eighteenth Annual Meeting of the Radiological Society of North America at Atlantic City, Nov. 28-Dec. 1, 1932.

equaled that resulting from a 140 per cent of an erythema given over a period of ten days, or 150 per cent given over fourteen days

The observations of Stenstrom and Mattick are best considered with those of the other mentioned workers, by comparing the rate of depreciation in radiation effect found by each. It is necessary that the comparison be based upon effects produced by a similar quality of radiation. Pfahler and Weatherwax found that a radiation effect produced by rays of a mean wave length of 0.16 \AA depreciated 50 per cent in twelve days, but Stenstrom and Mattick found the same loss in eight days.

TABLE I—COMPARISON OF THE RATE OF DEPRECIATION IN BIOLOGIC EFFECT PRODUCED BY RAYS OF A MEAN WAVE LENGTH OF APPROXIMATELY 0.16 \AA

	25% loss	50% loss	75% loss
Pfahler	5 days	12 days	24 days
Weatherwax	3 1/2 days	8 days	17 days
Stenstrom and Mattick			

Not only do the findings of these observers show a rather wide variation in the rate of depreciation in radiation effect, but MacKee (6), and Hazen and Whitmore (7) also noted skin reactions of variable degrees in employing the saturation method of treatment. This indicates that tissue recuperation deserves further study.

For observations of this sort it is necessary to employ a biologic method, because physical measurements do not determine the degree to which tissues will react to any amount of radiation. Since the reaction can be seen in the skin, this tissue can be used as a biologic indicator. The biologic unit cannot be based upon the tolerance of the skin to radiation, because it is impossible to establish a definite end point, neither can the degree of reaction be used, because of the difficulty in measuring the amount of discoloration in different individuals. However, by employing the so-called threshold erythema

these difficulties are lessened. By this means only the presence or absence of any reaction need be noted. The amount of radiation which will produce a desired percentage of visible skin reactions, and none in the others receiving the exposure, represents a threshold erythema dose. This has been defined as the amount of radiation which will produce a visible reaction in 80 per cent of the patients receiving the exposure within four weeks after the treatment, and no reaction in the remaining 20 per cent.

A logical approach to the problem of tissue recuperation from radiation effect seems to be the method employed by Stenstrom and Mattick. The reactions produced by single exposures were compared to those resulting from larger but divided doses. By this procedure they were able to estimate the quantity of radiation necessary to produce equal reactions in both single and divided doses. In comparing these two amounts of radiation as to quantity, and the interval of time between exposures, they were able to estimate the rate of depreciation of radiation effect in the skin.

An important refinement can be added to the above method by standardizing the degree of reaction by the use of a threshold erythema.

The experimental work for this study has consisted in determining the amount of radiation required to produce a threshold erythema by single and by divided doses. Patients were chosen at random from the various clinics of the hospital, and the skin on the extensor surface of the forearms used for the tests. A water-cooled 200 K V x-ray machine operating at 30 ma, with 0.5 mm Cu plus 2 mm Al filter, at a 50 cm target-skin distance was used for all of the tests. The size of the skin field was 10 by 10 cm on all of the patients. The output of the x-ray tube was measured at frequent intervals in order to deliver as accurate an amount of radiation as possible. Following the exposures the patients were observed at weekly intervals over a period of one

month The presence or absence of a skin reaction was recorded according to the independent observations of two individuals. Doubtful reactions were considered negative.

RESULTS OF EXPERIMENTS

A total of 65 tests was made to determine the threshold erythema dose for single exposures. The amount of radiation delivered to these patients varied from 400 roentgens² to 550 roentgens. Among the 14 patients who received 500 roentgens, 72 per cent showed a positive skin reaction. The incidence of positive reactions was the same for the seven patients who received 525 roentgens, but was increased to 94 per cent of the 17 patients who received 550 roentgens. Therefore, since a threshold erythema dose represents an amount of radiation which will produce a positive skin reaction in 80 per cent of the individuals receiving the exposure, this dose must be between 500 roentgens and 550 roentgens, when administered in the manner described. If a larger number of patients had received 525 roentgens, this group might have shown a greater percentage of positive reactions than the one receiving the lesser amount of radiation. However, 525 roentgens may be considered within the limits of experimental error of the threshold erythema dose for single exposures of radiation delivered under the conditions previously specified.

TABLE II — PERCENTAGE OF POSITIVE SKIN REACTIONS FOR DIFFERENT AMOUNTS OF RADIATION DELIVERED IN SINGLE EXPOSURES

	Number of roentgens at each exposure						
	400	425	450	475	500	525	550
Number of Tests	6	2	13	6	14	7	17
Per Cent Positive	33	50	70	50	72	72	94

² Whenever roentgens are mentioned in this article it is understood that the measurements were in air

In determining the threshold erythema dose for divided doses, two exposures of equal amounts of radiation were given at a 24-hour or 48-hour interval. A total of 52 tests was done with an interval of 24 hours between the two exposures. The doses these patients received varied from 300 roentgens at each exposure to 425 roentgens delivered at each treatment. Among the 27 patients who received 375 roentgens each time, 70 per cent showed positive skin reactions. In those who received 400 roentgens twice, 77 per cent had positive reactions, while all of the four patients to whom 425 roentgens were delivered at each of the two exposures developed a visible reaction. Therefore, the threshold erythema dose for two exposures of equal amounts of radiation given 24 hours apart is 400 roentgens at each time.

TABLE III — PERCENTAGE OF POSITIVE SKIN REACTIONS FOR DIFFERENT AMOUNTS OF RADIATION DELIVERED IN TWO EQUAL EXPOSURES 24 HOURS APART

	Number of roentgens at each exposure					
	300	325	350	375	400	425
Number of Tests	5	1	1	6	27	13
Per Cent Positive	0	0	33	70	77	100

Thirty-five tests were done to determine the threshold erythema dose for two exposures of equal amounts of radiation given 48 hours apart. The dose delivered to these patients at each exposure varied from 375 roentgens to 450 roentgens. Of the 14 patients who received two exposures of 400 roentgens each, 72 per cent showed positive skin reactions. Among the eight patients to whom 425 roentgens were delivered twice, 88 per cent were positive, and all of the nine patients who received two exposures of 450 roentgens developed a visible reaction in the irradiated skin. Very little difference was found in the amount of radiation required to produce a threshold erythema by two equal doses given 24 hours apart, and those given at

an interval of 48 hours. If 400 roentgens, or 425 roentgens were delivered to the skin, and the same area irradiated with an equal dose 48 hours later, about 80 per cent of the individuals who received the exposures showed a skin reaction. It seems reasonable to believe that a slight increase over the dose required to produce a threshold erythema by two exposures given 24 hours apart would be necessary if a 48-hour interval were used. Two exposures of 425 roentgens each have therefore been taken as more nearly representing the threshold erythema dose when administered 48 hours apart.

TABLE IV—PERCENTAGE OF POSITIVE SKIN REACTIONS FOR DIFFERENT AMOUNTS OF RADIATION DELIVERED IN TWO EQUAL EXPOSURES 48 HOURS APART

	Number of roentgens at each exposure			
	375	400	425	450
Number of Tests	4	14	8	9
Per Cent Positive	75	72	88	100

DISCUSSION

When the effect produced by single or multiple exposures is the threshold erythema, the degree of skin damage may be considered the same in both instances. When two treatments were used, each of the exposures was less than the amount of radiation required to produce a threshold erythema by a single dose. Therefore, the reaction produced by the divided doses may be considered to be due to the effect of the second exposure added to that which remained from the first.

The amount of radiation effect remaining after 24 hours is unknown, and, even if it were known, the effect could not be expressed properly in terms of roentgens. However, such an expression may be used in order to estimate the tissue recovery. If 400 roentgens delivered to a skin area, which had received the same dose 24 hours earlier, produces an effect equal to that resulting from a single ex-

posure of 525 roentgens, then the effect of 400 roentgens must have been added to a residual radiation effect which presumably would be produced by 125 roentgens. If this amount of equivalent radiation effect remains from the first 400 roentgens, the skin may be said to have recovered from 69 per cent of the damage resulting from the first exposure. By similar deductions from the data acquired on the 48-hour-interval tests, the recovery from the first exposure in this group must be 76 per cent.

This estimation of tissue recovery pertains only to the first exposure in the divided dose tests. That is, it pertains to the recovery occurring from an exposure of 400 roentgens and 425 roentgens at the end of 24 hours and 48 hours, respectively. This does not mean that the rate of recovery would be the same for greater doses, or different qualities of radiation, nor does it mean that the recovery from each dose would continue at the same rate over a protracted period of treatment with small doses.

One possible explanation of these data would be that a considerable percentage of recovery of normal skin takes place within 24 hours after exposure to radiation and then slowly at an unknown rate over an undetermined time. If, for example, an area of skin was being irradiated daily, the recovery from each dose might progress rapidly up to a certain point, but every exposure would add to the more permanent damage, which would accumulate more rapidly than recovery would take place. Also, large doses delivered in one exposure may produce a proportionately greater amount of the more permanent damage, so that the immediate recovery would be a lower percentage than occurs in smaller doses.

Further experiments will be done to determine the threshold erythema dose for various intervals between exposures, and for a greater number of treatments. Until this has been done no statement can be made upon the rate of tissue recuperation over a long protracted period of treat-

month The presence or absence of a skin reaction was recorded according to the independent observations of two individuals. Doubtful reactions were considered negative.

RESULTS OF EXPERIMENTS

A total of 65 tests was made to determine the threshold erythema dose for single exposures. The amount of radiation delivered to these patients varied from 400 roentgens² to 550 roentgens. Among the 14 patients who received 500 roentgens, 72 per cent showed a positive skin reaction. The incidence of positive reactions was the same for the seven patients who received 525 roentgens, but was increased to 94 per cent of the 17 patients who received 550 roentgens. Therefore, since a threshold erythema dose represents an amount of radiation which will produce a positive skin reaction in 80 per cent of the individuals receiving the exposure, this dose must be between 500 roentgens and 550 roentgens, when administered in the manner described. If a larger number of patients had received 525 roentgens, this group might have shown a greater percentage of positive reactions than the one receiving the lesser amount of radiation. However, 525 roentgens may be considered within the limits of experimental error of the threshold erythema dose for single exposures of radiation delivered under the conditions previously specified.

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	Number of roentgens at each exposure							
	300	325	350	375	400	425		
Number of Tests	5	8	1	1	6	27	13	4
Per Cent Positive	0	0	33	70	77	100		

Thirty-five tests were done to determine the threshold erythema dose for two exposures of equal amounts of radiation given 48 hours apart. The dose delivered to these patients at each exposure varied from 375 roentgens to 450 roentgens. Of the 14 patients who received two exposures of 400 roentgens each, 72 per cent showed positive skin reactions. Among the eight patients to whom 425 roentgens were delivered twice, 88 per cent were positive, and all of the nine patients who received two exposures of 450 roentgens developed a visible reaction in the irradiated skin. Very little difference was found in the amount of radiation required to produce a threshold erythema by two equal doses given 24 hours apart, and those given at

THE ROENTGEN ASPECT OF GASTRIC ULCER THERAPY

By N S ZEITLIN, M D, *Edgewater Hospital, Chicago*

SINCE Haudek introduced the barium method of gastric examination and found what is now called the Haudek niche, the diagnosis and treatment of gastric ulcer has changed entirely. The surgeons first took command of the field and soon some type of operation was done in every case showing a niche. However, we need not go into the details here of the results of gastro-enterostomy. Undoubtedly many cases were cured, but we cannot forget the frequency of recurrent gastric ulcer, jejunal ulcer, the primary mortality, and the later morbidity, which resulted in the evidence that gastro-enterostomy was not satisfactory for every case. More recently gastric resection has been proposed. Certainly, it seemed logical that the removal of the acid-forming area of the stomach would prevent any recurrence, but here again the occurrence of jejunal ulcers and the primary mortality of the operation make one hesitate to recommend it for every case.

It became evident to the workers in the field of gastric ulcer that each case had to be studied individually and that no one treatment would do for all cases. In looking for a means of studying the lesions more carefully the roentgenologist was called in to help. Here again is another instance in which, because of the close co-operation between the clinician and the roentgenologist, therapy was placed upon a logical and scientific basis. It is this comparatively recent development in which we are interested in this discussion. We believe that a careful roentgenologic study of the gastric niche will reveal upon repeated examinations the stage and course which the pathologic process is taking.

Every gastro-enterologist has met with a case in which a definite roentgen diagnosis of gastric ulcer niche was not corroborated at operation, which was performed after

several weeks of rest in bed. These cases, until very recently, were unaccountable. As late as 1927, Wright (1) reported cases of gastric hemorrhages with symptoms of gastric ulcer in which the x-ray findings were negative, after rest in bed. He concluded that these cases were as yet unexplainable. Other authors have given various explanations for this phenomenon. Carman believed that a small niche could be entirely hidden by a distended stomach and urged the examination of the partially filled stomach. The report of Bassler and Lutz (10) is much more disconcerting. They believe that the case of the vanished niche was never a case of gastric ulcer. In their report they call attention to the long-standing immobile peristaltic contraction which is frequently diagnosed as an ulcer niche. Haudek himself reports several cases in which he found great difficulty in differentiating a niche from a peristaltic wave. He was unable to account for such cases. Our own experience coincides with that of Cole and Stewart. We believe that a definite niche is pathognomonic for an ulcer, and further that the disappearance of this niche at the end of two weeks in no way discounts the validity of the original diagnosis.

This conclusion is arrived at in the light of the newer conception of the pathology, which is centered around the work of Franklyn White (7) and others. The former, writing in 1927, believed that the sudden disappearance of the ulcer niche could be explained by actual reparative processes. By operative and postmortem findings he was able to show that rest in bed would start rapid healing in the ulcer. In some of his cases, loose granulation tissue filled the niche after two weeks' rest in bed. Caylor (11), of Rochester, writing in 1926, divided the reparative processes into the following

ment However, the rate of tissue recuperation during the first 24 and 48 hours of treatment, with small exposures, appears to be more rapid than has been estimated by other authors If tumor tissue recuperates at a less rapid rate than normal structures, the saturation technic of irradiation should prove to be a very desirable method of treatment

SUMMARY AND CONCLUSION

1 Tissue recuperation has been studied by determining the quantity of radiation necessary to produce equal skin reactions in single and divided doses of 200 K V x-rays filtered by 0.5 mm Cu and 2 mm Al, using the threshold erythema as a standard reaction for comparison

2 The threshold erythema dose for a single exposure, given under the condition described, is 525 roentgens

3 The threshold erythema dose for equal amounts of radiation given at an interval of 24 hours is 400 roentgens for each exposure

4 The threshold erythema dose for equal amounts of radiation given at an interval of 48 hours is 425 roentgens for each exposure

5 The skin recovered 69 per cent of the immediate damage in 24 hours, and 76 per cent in 48 hours

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THE ROENTGEN ASPECT OF GASTRIC ULCER THERAPY

By N S ZEITLIN, M D , *Edgewater Hospital, Chicago*

SINCE Haudek introduced the barium method of gastric examination and found what is now called the Haudek niche, the diagnosis and treatment of gastric ulcer has changed entirely. The surgeons first took command of the field and soon some type of operation was done in every case showing a niche. However, we need not go into the details here of the results of gastro-enterostomy. Undoubtedly many cases were cured, but we cannot forget the frequency of recurrent gastric ulcer, jejunal ulcer, the primary mortality, and the later morbidity, which resulted in the evidence that gastro-enterostomy was not satisfactory for every case. More recently gastric resection has been proposed. Certainly, it seemed logical that the removal of the acid-forming area of the stomach would prevent any recurrence, but here again the occurrence of jejunal ulcers and the primary mortality of the operation make one hesitate to recommend it for every case.

It became evident to the workers in the field of gastric ulcer that each case had to be studied individually and that no one treatment would do for all cases. In looking for a means of studying the lesions more carefully the roentgenologist was called in to help. Here again is another instance in which, because of the close co-operation between the clinician and the roentgenologist, therapy was placed upon a logical and scientific basis. It is this comparatively recent development in which we are interested in this discussion. We believe that a careful roentgenologic study of the gastric niche will reveal upon repeated examinations the stage and course which the pathologic process is taking.

Every gastro-enterologist has met with a case in which a definite roentgen diagnosis of gastric ulcer niche was not corroborated at operation, which was performed after

several weeks of rest in bed. These cases, until very recently, were unaccountable. As late as 1927, Wright (1) reported cases of gastric hemorrhages with symptoms of gastric ulcer in which the x-ray findings were negative, after rest in bed. He concluded that these cases were as yet unexplainable. Other authors have given various explanations for this phenomenon. Carman believed that a small niche could be entirely hidden by a distended stomach and urged the examination of the partially filled stomach. The report of Bassler and Lutz (10) is much more disconcerting. They believe that the case of the vanished niche was never a case of gastric ulcer. In their report they call attention to the long-standing immobile peristaltic contraction which is frequently diagnosed as an ulcer niche. Haudek himself reports several cases in which he found great difficulty in differentiating a niche from a peristaltic wave. He was unable to account for such cases. Our own experience coincides with that of Cole and Stewart. We believe that a definite niche is pathognomonic for an ulcer, and further that the disappearance of this niche at the end of two weeks in no way discounts the validity of the original diagnosis.

This conclusion is arrived at in the light of the newer conception of the pathology, which is centered around the work of Franklyn White (7) and others. The former, writing in 1927, believed that the sudden disappearance of the ulcer niche could be explained by actual reparative processes. By operative and postmortem findings he was able to show that rest in bed would start rapid healing in the ulcer. In some of his cases, loose granulation tissue filled the niche after two weeks' rest in bed. Caylor (11), of Rochester, writing in 1926, divided the reparative processes into the following

ment However, the rate of tissue recuperation during the first 24 and 48 hours of treatment, with small exposures, appears to be more rapid than has been estimated by other authors. If tumor tissue recuperates at a less rapid rate than normal structures, the saturation technic of irradiation should prove to be a very desirable method of treatment.

SUMMARY AND CONCLUSION

1 Tissue recuperation has been studied by determining the quantity of radiation necessary to produce equal skin reactions in single and divided doses of 200 K V x-rays filtered by 0.5 mm Cu and 2 mm Al, using the threshold erythema as a standard reaction for comparison.

2 The threshold erythema dose for a single exposure, given under the condition described, is 525 roentgens.

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about 0.5 cm in length, along the lesser curvature and 0.5 cm in depth into the perigastric tissues. The shape of the niche is significant in our opinion; a cone-shaped niche indicates active penetration and must be carefully watched.

2 *Acute tenderness and rigidity of the abdomen* are frequently present. The tenderness, however, is dependent upon the degree of penetration and peritoneal involvement. Frequently when the penetration is slight and the peritoneum is not involved the tenderness is absent. It is just this type of gastric ulcer that is so frequently missed in fluoroscopic work. For this reason, we have made it a rule to take multiple plates in all cases which are negative in the fluoroscopic examination. Frequently such a small acute niche is seen only in the plates.

3 *Fixation of the stomach* is rarely seen in acute gastric ulcers, because of the lack of peritoneal reaction. The stomach is easily distended and freely mobile. As we shall see in chronic ulcers, this finding is extremely important in judging the possibility of rupture.

4 *Changes in the mucous membrane*. In the acute ulcer there is no demonstrable change in the roentgen studies of the rugous folds. It is true that occasionally, if the ulcer lies on the posterior wall, the edema may show a very slight spreading of the adjacent rugæ. This is very rare, however, and is not seen in the acute lesions of the lesser curvature.

5 *Incisura*. It is surprising how frequently this important sign is absent in acute cases. This can certainly be taken as indicating a lack of involvement of the circular fibers of the true muscular layers. In our own experience, we have rarely seen a definite incisura in small acute ulcers.

6 *Peristalses*. In our experience peristalses were hardly affected by small acute ulcers. For the most part the peristalses were increased in frequency and depth and passed through the ulcer area with only slight decrease in intensity and depth.

7 *Pylorospasm* is frequently present,

and in the absence of the duodenal ulcer should stimulate one to a very careful examination of the lesser curvature.

The small acute ulcer may either become chronic or go on to the healing stage. The chronic ulcer differs from the acute ulcer in the following ways:

1 *The Niche*.—This enlarges gradually and may reach the size of a quarter and even larger. Years ago Carman stated that niches approaching the size of a quarter were practically always malignant in nature; our own experience does not confirm this dictum. In our series, we had two cases presenting niches larger than a quarter. We were convinced that these were not malignant because under medical treatment instituted by Dr. Harry Singer at the Cook County Hospital, these cases showed a definite decrease in size of the niche. However, we believe that such large ulcers must be carefully watched and repeatedly examined. If progress is not seen within four weeks, surgical intervention is indicated, even though the roentgen findings do not show evidence of malignancy. The chronic ulcer is of the typical "plateau" type (Fig. 1) due to the peritoneal reaction and its resistance to further penetration.

2 *Tenderness*.—This is practically always present and at times so severe that the patient collapses during the examination—a frequent occurrence in our experience. A word of warning might be given here in regard to palpation in such cases. We are convinced that vigorous massage of the stomach in these cases will occasionally cause rupture. In one of our cases, showing a large chronic ulcer niche, rupture occurred several hours after the fluoroscopic examination. While this does not prove that the palpation caused the rupture, the evidence points strongly to such a conclusion. One certainly must be exceedingly careful in such cases, particularly when palpation is performed with a heavy lead glove or with a wooden spoon. We are now palpating such cases with the bare hand only.

3 *Fixation*.—When the chronic ulcer

- 1 The early cone-shaped niche,
- 2 The chronic plateau-shaped niche,
- 3 The healed stage with a pale pink scar

He quoted one case in which rest in bed for one week made the niche disappear, only to reappear again after a sudden hemorrhage. He explained the clinical course in the following manner and illustrated it by slides. The first rapid disappearance of the niche was due to the rapid accumulation of loose granulation tissue, by means of food trauma some of this granulation tissue was broken off, causing hemorrhage. At this time the niche again became visible, although smaller. A cure is not present until epithelium has grown over the crater. These are the experiences of only two authors, though similar findings were reported by such reputable men as Cole (10), Stewart (10), Haudek, and Hamburger (6).

This, in our opinion, accounts for some of the cases in which the surgeon fails to find the gastric pathology. Such failures could be easily obviated, however, by repeated x-ray examinations, particularly the day before the operation. If the niche is still present at this time, the surgeon should be able to locate it. However, it is essential that the surgeon be adept at gastric surgery. A surgical report of "no pathology found" does not necessarily discount the x-ray findings. We are convinced that the inexperienced surgeon will occasionally overlook gastric pathology; we have reason to believe that the palpating finger of the inexperienced surgeon may sometimes be less dependable than the eyes of a well-trained roentgenologist.

It can be seen that some gastric ulcers can heal very rapidly. It remains only to develop some means of determining the type of the pathologic process and the reaction to the treatment. Wright, Kunstler (12), Crohn (3), Forman (2), and many other workers have studied this phase of the subject and have come to the conclusion that a course of medical treatment is particularly indicated in the following cases:

- 1 Patients under 45 years of age (patients older may respond, but as a rule not so readily)
- 2 Cases with history of short duration, and with attacks of short duration and long normal intervals

It is fairly well agreed that obstruction, perforation, and some cases of bleeding need immediate surgical treatment. It may be mentioned here in passing, that hour-glass contraction *per se* is not an indication for operation. When the case of the chronic indurated gastric ulcer is brought up, there is some difference of opinion as to the proper course of procedure. While most clinicians are of the opinion that such cases are slow to react to medical treatment, we believe with Forman (2) that well-carried-out medical treatment is indicated before surgery. Crohn (3) says that in his experience chronic ulcer with perigastric pathology is difficult to heal medically. H. Singer, in a verbal report from his enormous amount of material at the Cook County Hospital, states that at least 75 per cent of these chronic indurated ulcers heal with medical treatment.

The internist must remember that in not immediately operating on gastric ulcer, he is assuming a great responsibility. He must be thoroughly capable of judging the course of the ulcer while under treatment. It is in just this phase of the treatment that roentgen studies are of paramount importance. The well-trained roentgenologist is not satisfied with a mere report of a gastric niche; his responsibility to the internist goes farther than that. He must be able to answer such questions as "Is the ulcer in question penetrating?" "Is it healing?" "Is it likely to heal?" "What chance of rupture is there?" We can now, by repeated fluoroscopic examination, make an attempt to answer the above questions by means of certain findings. We may not always be right, but we should make the attempt. An acute penetrating ulcer may show one or all of the following findings:

- 1 A cone shaped crater which is small,



Fig 3 Case 1 Twelve weeks after treatment The niche had disappeared Slight "skipping" was still present Not a complete cure



Fig 4 Case 2 Large gastric ulcer, under suspicion of malignancy because of size Note, however, adjacent rugae which appear slightly distorted but not broken

for checking the effect of the medical treatment. If the treatment is fortunate, the niche becomes smaller. It is surprising how rapidly this change may occur. In some of our cases, definite improvement was noted at the end of two weeks. We are of the opinion that if no improvement at all is noted at the end of six weeks, the treatment is not likely to succeed. As the niche grows smaller, tenderness decreases and is a good indication of diminished peritoneal reaction. The rugous folds, if they have not been previously distorted by contracting processes, gradually return to normal thickness. If considerable fibrosis has taken place the converging rugae will remain as evidence of the previous ulcer, even though the niche can no longer be seen. In our experience, such converging rugae should not lead to a diagnosis of ulcer without evidence of a niche or other roentgen signs of activity. The mensura gradually decreases in depth, and, as complete healing sets in, finally disappears entirely. As healing progresses,

the peristalses return to the involved area. We believe this a good criterion of complete cure. In our experience, complete cure should not be diagnosed until normal peristalses are seen passing through the region of previous "skipping." In cases of large niches with evidence of contraction and fibroses, peristalses do not return completely. There frequently remains a decreased intensity in the region of the previous "skipping."

It has been said that food may enter into a niche and obscure the findings, but in our experience this has not occurred. In order to prove this point, patients with known gastric niches were given soft food and immediately examined with barium. In a series of 15 cases examined in this way, barium never failed to outline the entire niche after very slight manipulation. However, the possibility of food filling the niche must be considered. In cases in which a gastric ulcer is suspected and not found, the examination should be repeated and the lesser curvature gently massaged



Fig 1 Case 1 Gastric ulcer with niche sub-acute Conical plateau type No incisura



Fig 2 Case 1 Six weeks after treatment niche decidedly smaller

reaches the size of 1 cm or more it is practically always fixed by the peritoneal reaction around it. Palpation will reveal distensible tissue around the niche when the niche is well on the lesser curvature and favors the posterior wall the peritoneal reaction is marked. Rarely is the niche on the anterior surface where the protective elements are considerably decreased. For this reason, such ulcers are particularly prone to rupture.

4 *Rugous Folds*—Changes in the rugous folds are frequently marked. Convergence of the folds, due to a contracting process, is common and always indicates a long-standing lesion. These converging rugæ must not be mistaken for the irregular, distorted, and broken rugæ of the ulcerating carcinoma.

5 *The Incisura*—This is very frequently found in chronic ulcers. At times the greater curvature is in contact with the lesser curvature, causing the spastic hour-glass contraction. Occasionally this hour-glass contraction is due to massive infiltration, fibrosis, and secondary con-

traction from the ulcerating process. An exact study of the rugous folds, when possible, will frequently reveal the true nature of the incisura. If one can demonstrate normal rugæ in the region of the incisura, one can safely diagnose spastic incisura; if the rugæ are considerably distorted, organic stricture is the more likely. Since treatment depends considerably upon this differentiation, one should not hesitate to repeat the examination before making a decision.

6 *Peristalses*—Here chronic and acute ulcers differ considerably. Peristalses, characteristically, do not pass through the large plateau type niche. This "skipping" of the peristalses definitely points to deep penetration of the muscular layers of the stomach.

7 *Pylorospasm*—This is present as in acute ulcers, but apparently no more frequently and offers no additional information.

There now remains the roentgen findings in the healing ulcer. These are very definite indeed and form the objective bases

in ruling out further penetration of a gastric ulcer. We have found it necessary to fluoroscope the patient every ten days during the first month and we believe that changes will be noted during such intervals in practically every case. The other condition that is so greatly feared when operation is not immediately performed is the possibility of the lesion becoming malignant. Here, statistics are certainly conflicting. At the County Hospital they have never seen a definite case of cancer developing at the site of an old ulcer. On the other hand, they have sufficient evidence to support the theory that such cases were carcinomatous from the onset and later degenerated, causing ulcers. Here are some of the statistics showing the percentage of gastric carcinomas containing evidence of previous benign lesions: Finsterer, 21 per cent, Ewing, 5 per cent, Aschoff, rare, Wright, very rare, Crile, less than 5 per cent, Mallory, never has seen it, McCarthy, at the Mayo Clinic, claims to have found evidence of a previous ulcer in 71 per cent of the carcinomas of the stomach. But the question is not as important as it may seem. While supporting the medical treatment, we still say that should the ulcer niche not decrease in size in response to treatment, an operation must be considered at the end of four weeks.

It has been our custom to urge operation even at the end of three weeks in cases in which the x-ray findings were not entirely typical of benign ulcer. Obviously, a carcinomatous ulcer would not decrease in size so that for all practical purposes the x-ray will indicate the necessity of operative procedure. Our series includes 20 patients with gastric ulcers of varied types: five cases were followed through to complete healing as demonstrated by the return of normal peristalsis; eleven cases left the hospital after several weeks' stay with a definite decrease in the size of the niche; two cases of large, chronic, indolent ulcers left the hospital improved at the end of three weeks—they showed no appreciable decrease in the size of the niche. Opera-



Fig 7 Case 3 Eight weeks after treatment. Unusually rapid disappearance of the niche. Unquestionably a benign lesion.

tion was urged but refused by the patients. Two cases were operated upon. One was a ruptured ulcer apparently caused by a too vigorous examination, and the other was a chronic indolent ulcer which showed only a slight reaction to treatment, and in a case in which the economic circumstances of the patient demanded an attempt at quick relief.

In conclusion we should like to emphasize the following:

- 1 Each case of gastric ulcer must be studied individually and treatment started according to the type of ulcer, behavior of the lesion while under treatment, and the age and condition of the patient.

- 2 The old idea of immediate operation is not supported by our present experiences.

- 3 The roentgenologist must be prepared to give fairly accurate data as to the pathologic stage of the ulcer and must not be satisfied with merely diagnosing its presence.

- 4 A careful roentgenologic examination should, in most cases, indicate whether the ulcer is acute, chronic, penetrating, or inactive.

- 5 The absence of a niche at operation after several weeks of rest in bed does not indicate an error in diagnosis. A niche



Fig 5 Case 2 Two months after treatment. Niche is much smaller Without question it is a benign lesion

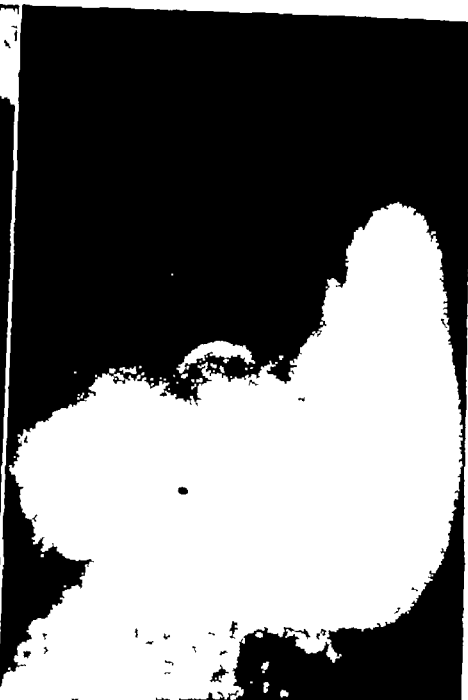


Fig 6 Case 3 Gastric ulcer niche Large size points to malignancy Decided for therapeutic test first

We have not meant in our previous statements that one should rely on x-ray findings alone in judging the course of the ulcer on the contrary, symptoms are of great importance This much is true, however, symptoms may be relieved without appreciable improvement in the gastric niche such cases are to be watched very carefully If symptoms disappear and the niche does not decrease in size, we believe that an exploratory operation is indicated No one sign may be ignored and the treatment must rest upon both clinical and x-ray findings The results of medical treatment have varied somewhat with different authors this is a natural outcome considering the many types of ulcers Forman (2) reported 42 per cent of the cases well or improved after leaving the hospital Nielson (4), in 1923, had followed up his cases for 22 years Acute and recurrent gastric ulcers showed a 60 per cent cure Chronic, so-called indolent ulcers showed results in only 9 per cent In Franklyn White's

series of cases of persistent ulcer craters in patients over 45 years of age, 50 per cent of the ulcer craters disappeared within two months Dr H Singer, of the County Hospital, Chicago, verbally reported a 70 per cent cure in cases of so-called chronic indolent ulcers

While the advantages of successful medical treatment of gastric ulcer are self-evident, the dangers are not to be denied First comes the question of rupture while under treatment Jordan (5), writing in 1925, states that he had no difficulty in judging the imminence of rupture of the ulcer He contends that after two weeks of proper treatment, the niche should get smaller, and at the end of a month it should entirely disappear Thus, in the main, has been his experience at the County Hospital as well as the experience of most of the workers in this field, but it cannot be too greatly emphasized that the repeated examination of the stools and fluoroscopic examinations are essential

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

ABUSE OF THE FLUOROSCOPE

The fluoroscope is an indispensable piece of x-ray apparatus, and when used by a roentgenologist it renders valuable diagnostic information. However, it may be considered one of the most hazardous of all x-ray apparatus. When reports of x-ray burns were frequent, the fluoroscope accounted for a large portion of them. This was particularly true in the instances wherein the roentgenologists suffered burns. Thus it is well known to the radiological profession that the use of the fluoroscope is attended by a certain danger, even in the hands of experts, and has a distinct limitation to certain x-ray diagnoses.

Our attention has been called to a monthly review, issued by the National Tuberculosis Association (May, 1931, 14, No 5), in which there appeared a lengthy presentation on the importance of the fluoroscopic examination in suspected cases of pulmonary tuberculosis.¹ In order to fortify their situation, and impress their readers with certain arguments in favor of the fluoroscopic examination, they present an elaborate reference to foreign contributors. We are all familiar with the ease with which patent medicine people and others can obtain recommendations of their products by European physicians, some of these foreigners are very obliging and enthusiastic with their statistics. For instance, the author from whom the National Tuberculosis Association quotes as having used the fluoroscope in the diagnosis of pulmonary tuberculosis says that he himself "has examined 4,836 students of both sexes with the following results: Inactive lesions, 14.8 per cent, partially active lesions, 1.3 per cent, active closed lesions, 0.17 per cent, open lesions, 0.39 per cent, total tuberculous lesions found, 16.66 per cent."

It should be explained that at the time this survey was made the financial status of the European peoples was bad, and every economical measure was resorted to. Since the

fluoroscopic method of examination was much less costly than the use of films, the former method was adopted. This is the only reason we can see why such a procedure was followed.

It would appear that the National Tuberculosis Association is either poorly advised in regard to roentgenological matters or they lack the proper understanding of properly educating the public. Certainly we cannot believe that a reputable roentgenologist of experience would use the fluoroscopic examination for the early diagnosis of pulmonary tuberculosis rather than the film method. We agree that in a number of instances wherein a chest examination is being made for suspected pulmonary tuberculosis, the fluoroscope can be of aid in visualizing adhesions of the diaphragm, aneurysms, etc. The x-ray films are universally used in the diagnosis of early pulmonary tuberculosis, and it is, then, for the N. T. A. to know and practise this.

We cannot understand how a large and important organized body would unhesitatingly recommend the use of the fluoroscope, with its attendant dangers and limitations in the diagnostic field of medicine, for the diagnosis of pulmonary tuberculosis. Such propaganda can and has done a great deal of harm, and those who are inclined to believe that the indiscriminate use of the fluoroscope is justifiable should be warned by someone with experience of its danger. They should be told that it does not furnish the desired diagnostic information in pulmonary tuberculosis, this can be obtained only by x-ray films.

It has not been long since we took exception to this same National Tuberculosis Association for its recommendation of the use of sensitive paper instead of films for the diagnosis of tuberculosis by the x-ray. It should be recalled that the Association, in 1931, recommended the use of the fluoroscope in the diagnosis of early tuberculosis, and, in 1934, sensitive paper. We wonder what will be the next change in 1935. We hesitate to make a prediction, as only a bold prophet will foretell its future action.

We consider that the abuse of the fluoroscope is of serious importance, especially when so

¹ We have just received the leaflet of the N. T. A. (September, 1931) in which the prediction is made that "The day will come when most physicians will have fluoroscopes in their offices, and will be sufficiently trained to use these not only as an essential aid in the detection of early tuberculosis," etc. (The italics are mine.)

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7 The close co-operation between the internist and the roentgenologist is urged in the best interest of the patient

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 - (12) KUNTSLER M B Med Jour and Record April 30, 1927, 124, 796
 - (13) FREIDHEIM (Ab), Jour Am Med Assn 83, 1282
 - (14) DIAMOND Am Jour Med Sci, June 1927 163, 548
-

recommend as wide publicity of this Board's existence and approval as is possible to the public, consistent with ethical practices, as the most effective safeguard which can be afforded them

RESOLVED that we recommend the refusal of advertising matter in National and State Journals when the companies concerned are advertising a medical consulting service or are advertising such service through the mails in connection with their sale or rental of radium

RESOLVED that we disapprove of any doctor's acting as a consultant to a commercial company carrying on such a campaign of public or private advertising and that we consider such an association sufficient grounds to warrant disbarment from the approval of the National Board of Radiological Examiners

RESOLVED that we recognize the ethical commercial company as a necessity. It is the advertised consulting service that is at fault. It is recognized that such restrictions on the advertising of a medical service will in no way hamper properly qualified radium therapists in obtaining adequate supplies of radium or radon for the purposes for which they are qualified to use it

RESOLVED that we approve an informal medical consultant for the guidance of those commercial companies who refrain from advertising such professional service, either publicly or privately, and that in such case their informal consultant be one approved by the National Board of Radiological Examiners

ANNOUNCEMENTS

PRELIMINARY PROGRAM

ANNUAL MEETING

Let all those who have thoughts of attending our Memphis Annual Meeting, to be held at Memphis, Tennessee, December 3 to 7, inclusive, do so without fear of disappointment

Your Committees have been working overtime to insure for you the utmost value for every moment you will spend there. No stone has been left unturned to secure whatever might be of assistance in making that occasion a memorable one

It has been thought advantageous to incorporate several new features in the program which will enhance the value to the hundreds attending. Three distinct types of presentation will be offered, covering symposia on all

the latest developments of our work. The General Sessions each morning will be in the form of lectures giving us the scientific contributions from our most outstanding men and covering the field of radiology to date

The Scientific Exhibits will be featured every afternoon. We have arranged that each exhibitor will be given the opportunity before the General Assembly of amplifying the cardinal features of his exhibit

Not the least important will be the daily Clinics, offering to us all the opportunity to obtain a concentrated post-graduate course through practical demonstration and questioning

Let me also mention the Commercial Exhibits which will be shown. As a courtesy to our Commercial Exhibitors and for our own information we hope to arrange an opportunity for each manufacturer to have at least five minutes on the General Sessions program to announce his latest contributions to radiology

In addition to all these, we are introducing the Carman Lecture, which will be instituted on what we are pleased to call "The Carman Night," December 4. This will be an important addition to our program

Wednesday night, "Memphis Night," is going to be different—something which the members from the North, East, and West will long remember—a real event with a Southern setting

We have endeavored to maintain the high standard of our Banquet Night. It will be replete with good things—not too much but just enough

Do not neglect our ladies. The local hosts are preparing to receive them. Garden parties, teas, drives, and banquets will insure days full of happy associations

We are going to Memphis, Tennessee, a setting in the historical South, renowned for its hospitality and graciousness. All has been done to insure for everyone a most profitable and enjoyable time. You cannot afford to miss it. Get in touch with J. Cash King, M.D., the Chairman of Hotels, Memphis, who will make the necessary reservations for you. Hoping to see you there

W. HERBERT MCGUFFIN, M.D., *President*

Opening Ceremonies

Monday, December 3, 1934. W. S. Lawrence, M.D., Local Committee of Arrangements, *Chairman*

many high-powered salesmen of x-ray equipment are trying to sell fluoroscopes to be used for all kinds of x-ray diagnosis. No doubt many physicians, after reading this pronouncement by the National Tuberculosis Association have equipped themselves with a fluoroscope, and begun to make diagnoses of pulmonary tuberculosis.

We wish at this time to issue a warning to physicians who contemplate purchasing fluoro-

scopic apparatus from high-pressure salesmen that this is a lot of bally-hoo. Don't believe it—it can't be done.

Our attention has been called to this condition by members of the medical profession, and we unhesitatingly condemn the indiscriminate use of the fluoroscope. We urge all roentgenologists to institute a campaign of education in its use and abuse.

COMMUNICATIONS

AMERICAN RADIUM SOCIETY

RESOLUTION

The following resolution was presented by the Executive Committee and adopted unanimously by the American Radium Society, Cleveland Session, June 12, 1934.

WHEREAS, it has been proven that radium or x-rays, when used properly, and in sufficient quantity, is efficient in the treatment of cancer in certain locations, and

WHEREAS, there is a general fear in the public mind from x-ray or radium burns, which, because of this fear, prevents competent radiologists from using sufficient radium or x-ray to produce the best results,

BE IT RESOLVED that we as radiologists recognize that in the treatment of malignant disease, it is often necessary to carry the treatment on to the extent of producing a violent reaction in the surrounding tissues, which may cause the skin to peel, and blisters to form, in order to give sufficient treatment to overcome the malignant disease. We believe, therefore, that it is justifiable to produce a second degree radiodermatitis when necessary.

RESOLUTIONS ADOPTED BY AMERICAN
RADIUM SOCIETY AT ANNUAL MEETING,
CLEVELAND, JUNE 12, 1934, ALSO ADOPTED
BY AMERICAN COLLEGE OF RADIOLOGY,
JUNE 12, 1934

The Indiscriminate Use and Rental of Radium

WHEREAS it is now recognized that radium has been demonstrated to be of definite value in the treatment of disease, and

WHEREAS some States and many communi-

ties in the country have little or no radium available, and

WHEREAS funds are not always available for the purchase of suitable preparations of radium for use by those physicians who are qualified in radium therapy, and

WHEREAS we recognize that radium is an agent quite as potent for doing harm as for doing good when used without sufficient skill or training, and with the hope of protecting the uninformed public from serious and irreparable injury from improper and insufficient treatment,

BE IT RESOLVED that we consider it improper, unethical, and detrimental to the science of radiology and to the good of suffering humanity for commercial laboratories to attempt to give advice or directions as to the use of radium in the case of a patient whom the person giving that advice has not even had the opportunity to examine. In other words, it is just as difficult to give such advice and directions as it would be for a surgeon to give directions for the use of rented surgical instruments so that an untrained physician might attempt an operation. Various commercial companies advertise both in the journals and through the mails, medical advice for the purpose of making sales or renting radium or radon. This places those corporations in the field of practising medicine.

BE IT RESOLVED that the same criticism be applied to institutions which rent or furnish their radium to those members of their Staff or outside of the Staff who are unskilled in radium application.

RESOLVED that the same criticism applies to many individual owners of radium.

RESOLVED that we regard the approval of the National Board of Radiological Examiners as the minimum standard for those assuming the responsibility for using radium. We

Tuesday, December 4, 1934, 2 00-3 00 P M

Executive Session

3 00-3 30 P M

"Unification of Radiological Societies"
Rollin H Stevens, M D, President of American Radium Society, 1933-34, Detroit, Mich

Tuesday, December 4, 1934, 8 30 P M

Carman Night

Introduction, President W H McGuffin, M D

The Carman Lecture

"Some Phases of Radiologic Diagnosis of Gastric Cancer" B R Kirklin, M D, Head of Section of Roentgenology, Mayo Clinic, Rochester, Minn

An Appreciation

"The Debt of Surgery to Roentgenology" D C Balfour, M D, Surgical Section, Mayo Clinic, Rochester, Minn

Closing, W L Williamson, M D, President of Memphis and Shelby County Medical Society

Wednesday, December 5, 1934, 8 30-10 30 A M

Symposium on Chronic Arthritis

Arranged by H P Doub, M D, Detroit
"Medical Aspects of Chronic Arthritis"
Ralph A Kinsella, M D, Professor of Medicine, St Louis University, St Louis

"Surgery as an Adjunct to the Treatment of Arthritis" Willis C Campbell, M D, Professor of Orthopedic Surgery, University of Tennessee, Memphis, Tenn

Roentgen Diagnosis of Chronic Arthritis
Howard P Doub, M D, Roentgenologist, Henry Ford Hospital, Detroit, Mich

"Physical Therapy, Fever Therapy and Radiotherapy of Chronic Arthritis" Arthur U Desjardins, M D, Head of Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minn

Discussants Robert S Stone, M D, University of California, Oakland, Calif

John D Camp, M D, Mayo Clinic, Rochester, Minn

Wednesday, December 5, 1934,

10 30-12 30 A M

Symposium on Physics of Radiation

Arranged by Dr Lauriston Taylor, Washington, D C

"Intensity and Dosage near Radium Needles" Dr C G Laurence, Canadian National Research Council, Ottawa, Canada

"The Correlation of X-radiations Produced with Different Voltages and Filtrations" Lauriston S Taylor, Chief, X-ray Laboratories, National Bureau of Standards, Washington, D C

"Further Studies in the Relation between the Roentgen and Radium Dose in Milligram Element Hours at 1 cm Distance" Otto Glasser, Ph D, Director, Department of Radiation Research, Cleveland Clinic Foundation, Cleveland, O

"Quality Measure and Distance Doses of White X-ray Beams" A Mutscheller, Ph D, Director of Research, Westinghouse X-ray Company, Inc, New York City

"A Distribution of Roentgen Radiation in the Pelvis in the Treatment of Carcinoma of the Cervix" A N Arneson, M D, and Edith H Qumby, M A, Memorial Hospital, New York City

Wednesday, December 5, 1934, 2 00-3 30 P M

Symposium on Ductless Glands

"X-ray Treatment of Hypo glycemias" S C Barrow, M D, Radiologist, Schumpert Sanatorium, Shreveport, La

"Radiotherapeutic Treatment of Hypertension and Diabetes" James H Hutton, M D, Chicago

Discussant Maximilian J Hubeny, M D, Chicago

Thursday, December 6, 1934, 8 30-10 30 A M

Symposium on Mouth and Neck

Arranged by Albert Soiland, M D, Los Angeles, Calif

"Intra-oral Cancer and its Treatment" Orville N Meland, M D, Soiland Clinic, Los Angeles, Calif

"The Treatment of Laryngeal Carcinoma by the X-ray Report of Cases" I Seth Hirsch, M D, Professor of Roentgenology, New York University and Bellevue Medical School, New York City, and Samuel M Baum, M D, Radiation Therapist, Beth Israel Hospital, New York City

"Treatment of Malignancies of Larynx and Hypopharynx" L H Garland, M D, San Francisco

"The Treatment of Cancer of the Cheek" G E Pfahler, M D, Professor of Radiology, Graduate School of Medicine, Philadelphia

Addresses of Welcome

Honorable Watkins Overton, Mayor of Memphis

E C Ellett, M D, Representative of Medical Profession of Memphis

Mr George Morris, Editor-in-chief, *Memphis Commercial Appeal*

Acceptance of Memphis Hospitality

T A Burcham, M D, *Chairman*, Executive Committee, Radiological Society of North America

Formal Opening of Convention

W H McGuffin, M D, President, Radiological Society of North America

Formal Opening of Commercial Exhibits

C H Heacock, M D, *Chairman*, Transportation and Commercial Exhibits Committee

SCIENTIFIC SESSION

Monday, December 3, 1934, 10 30-12 30 A M

Symposium on Urology

Arranged by B H Nichols, M D, Cleveland, Ohio

"Excretion Urography in Differential Diagnosis of Some Renal and Perirenal Lesions" Robert A. Arens, M D, Roentgenologist, and A E Jones, M D, Urologist, Michael Reese Hospital, Chicago

"Multiple Urograms in Urinary Diagnosis" E C Baker, M D, Roentgenologist, and J S Lewis, M D, Urologist, Youngstown City Hospital, Youngstown, Ohio

"Urological Problems in Childhood" W J Engel, M D, Urologist, Urological Section, Cleveland Clinic, Cleveland, Ohio

"Roentgen Therapy in Wilm's Tumor (Embryonic Carcinoma) of the Kidney, with an Analysis of Six Cases" E A Pohle, M D, Ph D, Dept of Radiology and Physiotherapy, University of Wisconsin, Madison, Wis

Discussant R S Hennessey, M D, Urologist, Memphis, Tenn

Monday, December 3, 1934, 2 00-3 30 P M

Symposium on Gastro-intestinal Tract

Arranged by B R Kirklin, M D, Rochester, Minn

"Increased Irritability of the Gastro-intestinal Tract A Discussion of Disturbed Physiology" Barton A Rhinehart, M D, Associate Professor, Roentgenology, Arkansas University School of Medicine, Little Rock

"Importance of Roentgen Gastric Functional Study in the Differential Diagnosis of Pyloric Lesions" W H Meyer, M D, Director, Department of Roentgenology, New York Post-graduate Medical School and Hospital of Columbia University, New York City

"The Study of the Esophagus in Relation ship to the Heart and Great Vessels" Samuel Brown, M D, Assistant Professor of Roentgenology, University of Cincinnati, Cincinnati, O, and Justin E McCarthy, M D, Radiologist, Good Samaritan Hospital, Cincinnati, O

Monday, December 3, 1934, 7 00 P M

Counselors' Dinner

Executive Session
Counselors' Reports
Committees' Reports
President's Address

Tuesday, December 4, 1934, 8 30-10 30 A M

Symposium on Silicosis

Arranged by E C Ernst, M D, St Louis, Mo Roentgenologic Aspect

Etiological Aspect R R Sayers, M D, Medical Officer-in-Charge of Industrial Hygiene and Sanitation of the Public Health Service, Washington, D C (*by invitation*)

Pathological Aspect Leroy U Gardner, M D, Director of the Saranac Laboratory for the Study of Tuberculosis of The Edward L Trudeau Foundation, Saranac Lake, N Y, (*by invitation*)

Clinical Aspect Anthony J Lanza, M D, Assistant Medical Director of the Metropolitan Life Insurance Company, New York City (*by invitation*)

Tuesday, December 4, 1934, 10 30-12 30 A M

Symposium on Thoracic Neoplasms

Arranged by J T Farrell, Jr, M D, Philadelphia

"Congenital Cysts of the Lungs" James L Dubrow, M D, Des Moines, Iowa

"Primary Carcinoma of the Lungs" Charles H Heacock, M D, and J Cash King, M D, Memphis

"Extra-pulmonary Thoracic Tumors" Carleton B Perce, M D, Ann Arbor, Mich
"Mediastinal Tumors" William A Evans, M D, and E R Witwer, M D, Detroit

"Pulmonary Metastases" J T Farrell, Jr, M D, Assistant Roentgenologist, Jefferson Hospital, Philadelphia

"Leukemia" E A Pohle, M D, Ph D, Dept of Radiology, University of Wisconsin, Madison, Wis

"Cholecystographic Diagnosis" David S Beilin, M D, Radiologist, Augustana Hospital, Chicago

"Detailed Procedure in Determining Proper Roentgen Dosage for Any Given Case" A W Erskine, M D, Radiologist, Cedar Rapids, Iowa

"Therapeutic Injections of Lipiodol as a Relief for Pains of Loco-motor System and Their Roentgenological Control" J Forestier, M D, Aix les-Bains, France.

"Malignancy of the Lower Lip" W H McGuffin, M D, Director, Radium and X-ray Institute, Calgary, Alberta, Canada

"Radiography of the Diaphragm and its Abnormalities" Kenneth D A Allen, M D, Denver, Colorado

"Treatment of Uterine Malignancy" Norman Arneson, M D, New York City

"Roentgenology of the Spine" Howard P Doub, M D, Detroit, Michigan

"Examination of the Accessory Sinuses with Opaque Oils" Edwin C Ernst, M D, St Louis

"Retrograde Pyelography" Theodore R Fetter, M D, Philadelphia

"Roentgenography of the Sphenoid Sinus" Amédée Granger, M D, New Orleans, La

"Roentgen Therapy of the Spinal Nerves for Pain" Byron H Jackson, M D, Scranton, Pa

"Roentgen Examination of the Breast" Ira H Lockwood, M D, Kansas City, Mo

"Roentgen-ray Treatment with 800 K V Pulsating Current" Henry Schmitz, M D, Chicago

"Radiation Therapy of Carcinoma of the Breast" Max Cutler, M D, Chicago

"Roentgen Examination of the Colon," H E Ilhck, M D, New York City

Female Pelvis for Different Port Arrangements and Target-skin Distances" A N Arneson, M D, and Edith H Quimby, M A, Associate Physicist, Memorial Hospital, New York City

"Differential Diagnosis of Pulmonic and Gastric Lesions" I S Trostler, M D, Radiologist, Chicago

"Roentgen Kymography—The Graphic Representation of Visceral Movements" I Seth Hirsch, M D, Professor of Roentgenology, New York University and Bellevue Medical School, New York City

"The Position of Esophagus under Abnormal Conditions of Heart and Great Vessels" Samuel Brown, M D, Assistant Prof Roentgenology, University of Cincinnati, Cincinnati, O, and Justin E McCarthy, M D, Radiologist, Good Samaritan Hospital, Cincinnati, O

"Important Factors in Technic of Soft Tissue Radiography" John R Carty, M D, Radiologist, New York Hospital, New York City

"Observations on Functioning of Radio-frequency High Voltage X-ray Apparatus, with Some of its Physical Characteristics" Robert S Stone, M D, Ass't Prof Roentgenology, Univ of California Medical School, San Francisco, Calif

"Benign Tumors of the Stomach (with Particular Reference to Their Incidence and Malignant Degeneration)" Leo G Rigler, M D, Professor of Radiology, University of Minnesota, Minneapolis, Minn, and Lester G Ericksen, M D, Roentgenologist, Finley and Mercy Hospitals, Dubuque, Iowa

"The Effect of Thorium Dioxide Sol on the Human Liver and Spleen" Leo G Rigler, M D, Professor of Radiology, University of Minnesota, Minneapolis, Minn, and Rudolph Koucky, M D, and A L Abraham, M D, Minneapolis, Minn

"Biliary Colic with Fistula" H B Podlasky, M D, Associate Clinical Professor and Director, Dept of Roentgenology, Marquette University, Milwaukee, Wis

"Neurotrophic Lesions of Lower Extremities Caused by Myelodysplasia in the Spinal Cord" Lester A Smith, M D, Asst Professor of Radiology, University of Indiana Medical School, Indianapolis, Indiana

"Cases of Xanthomatosis Involving Bone" Lester A Smith, M D, Asst Professor of Radiology, University of Indiana Medical School, Indianapolis, Indiana

SCIENTIFIC EXHIBITS

"New Safety Control Devices for Filters in X-ray Therapy" Gentz Perry, M D, Radiologist, Evanston, Illinois

"Acute Sclerosis Cases in Pulverizing Plants of New Jersey A Radiologic, Microscopic, and Experimental Survey" Raphael Pomeranz, M D, Associate Roentgenologist, Newark Beth Israel Hospital, Newark, N J

"Roentgen Radiation in Carcinoma of Cervix Uteri—Distribution of Radiation within

Thursday, December 6, 1934, 10 30-12 30 A M
Symposium on Breast and Pelvis

Arranged by Albert Soiland, M D, Los Angeles, Calif

"Application of Endocrine Studies to Radiation Therapy, with Special Reference to Breast and Pelvic Pathology" Milton Friedman, M D, and Rita Finkler, M D, Newark, N J

"Pre-operative and Pre-radium Irradiation of Carcinoma of the Breast, Cervix, and Urinary Bladder" J Thompson Stevens, M D, Director Depts for Study and Treatment of Neoplastic Diseases, Montclair Community Hospital, Montclair, N J

"Breast Cancer Its Detection and Treatment" B H Orndoff, M D, Professor Radiology, Loyola University School of Medicine, Chicago

"Radiotherapeutic Aspects of Adenomyoma of Recto-vaginal Septum" H H Bowing, M D, Head of Section on Radium Therapy, Mayo Clinic, Rochester, Minn

Thursday, December 6, 1934, 2 00-3 00 P M

EXECUTIVE SESSION

3 00-3 30 P M

"Economics"

Thursday, December 6, 1934, 8 30 P M

Banquet

Music

Announcements, W S Lawrence, M D,
Local Committee of Arrangements

Chairman's Address, President W H McGuffin, M D

Awards

Guest Speaker, Honorable Harvey T Harrison, Little Rock, Arkansas "The Funny Bones of the Human Head, by the Light of the Co(s)mⁱc Ray"

Induction of new officers and presentation of gavel to new President, Lloyd Bryan, M D

Friday, December 7, 1934, 8 30-10 30 A M

Symposium on Dermatology

Arranged by Rollin H Stevens, M D, Detroit, Mich

Friday, December 7, 1934, 10 30-12 30 A M

Symposium on Bone Tumors

Arranged by R T Wilson, M D, Temple, Texas

"Osteogenic Sarcoma Roentgenologic Characteristics" R T Wilson, M D, Scott and White Clinic, Temple, Texas

"Bone Lesions in Children" J I Mitchell, M D, Memphis

"Osteogenic Sarcoma Pathologic Characteristics" Charles Phillips, M D, Temple, Texas
Discussants Max Kahn, M D, Baltimore
Willis Campbell, M D, Memphis

Friday, December 7, 1934, 2 00-3 30 P M

Symposium on Spinal Lesions

Arranged by W W Wasson, M D, Denver

"Radiological Study of Vertebral Column" Bernard R Mooney, M D, Radiologist to Edmonton General Hospital and Misericordea Hospital, Edmonton, Alberta, Canada, and P H Malcolmson, M D, Radiologist, Edmonton, Alberta, Canada

"The Early Stages of Spondylitis Ankylopoietica" Jacques Forestier, M D, Aix-les-Bains, France

CLINICS

Diagnostic and therapeutic clinics have been arranged for the meeting Each clinic will be held on two afternoons and each clinician will demonstrate, by means of apparatus and appliances, the method of carrying out the diagnostic and therapeutic procedures of his subject Lantern slides will supplement these demonstrations so that they will be diagnostic as well as technical The following have agreed to present clinics Undoubtedly others will be added to the program

"Esophagus" J T Farrell, Jr, M D, Assoc in Roentgenology, Jefferson Medical College, Philadelphia

"Stomach and Duodenum" B R Kirklin, M D, Head of Section of Roentgenology, Mayo Clinic, Rochester, Minn

"Ventriculography" W E Chamberlain, M D, Prof Radiology, Temple University Medical School, Philadelphia

"Intravenous Urography" B H Nichols, M D, Roentgenologist, Cleveland Clinic, Cleveland, O

"Spinal Cord Tumors" John D Camp, M D, Associate in Section on Roentgenology, Mayo Clinic, Rochester, Minn

"Pelvimetry" R P Ball, M D, Director of Laboratories, The Baroness Erlanger Hospital, Chattanooga, Tenn, and S S Marchbanks, M D, Dermatologist, The Baroness Erlanger Hospital Chattanooga, Tenn

A landscaped parkway skirts the northern, eastern, and southern sides of the central portion of the city, connecting at its western end with the partially completed Riverside Boulevard which will overlook the Mississippi from an embankment under construction approximately half-way between the top of the Bluffs and the waterline. On the Parkway are located Riverside Park, a scenic area of more than six hundred acres overlooking the river, Overton Park, which includes one of the city's three public golf courses, the Overton Park Zoo, one of the five largest zoological gardens in America, and the Brooks Memorial Art Gallery. Supplied by artesian wells, Memphis has the largest water system of its kind in the world.

It is likewise a center of medical sciences with hospitals which serve a large area outside of the city proper.

For the convenience of our readers who are planning to attend the Annual Meeting of the Radiological Society of North America at Memphis, Tennessee, from Monday, Dec 3 to Friday, Dec 7, 1934, we have ascertained the names of the hotels in Memphis, together with their rates, which we present herewith.

The meeting is to be held in the Hotel Peabody, and for that reason we show several views from which one may judge of the accommodations available.

The indications seem to point to the largest attendance in a number of years, so it is suggested that hotel reservations be made early.

MEMPHIS HOTEL RATES

Hotel Peabody (625 rooms—all with bath)

Single	Double	Twin-bedded
\$3 00	\$4 00	\$6 00
3 50	5 00	7 00
4 00	5 50	8 00
5 00	6 00	

\$1 50 each for extra beds in room

Studio Suites, \$8 50 to \$20 00 per day

Hotel Gayoso (300 rooms—120 without bath)

WITHOUT BATH

Single	Double and Twin	For Three
\$1 50	\$2 50	\$3 50
2 00	3 00	4 00



Hotel Peabody, Memphis, Tenn.
View of Studio Suite

WITH BATH

Single	Double and Twin	For Three
\$2 00 to \$4 00	\$3 50 to \$6 00	\$4 50 to \$7 50

Hotel Chisca (400 rooms—50 without bath)

WITHOUT BATH

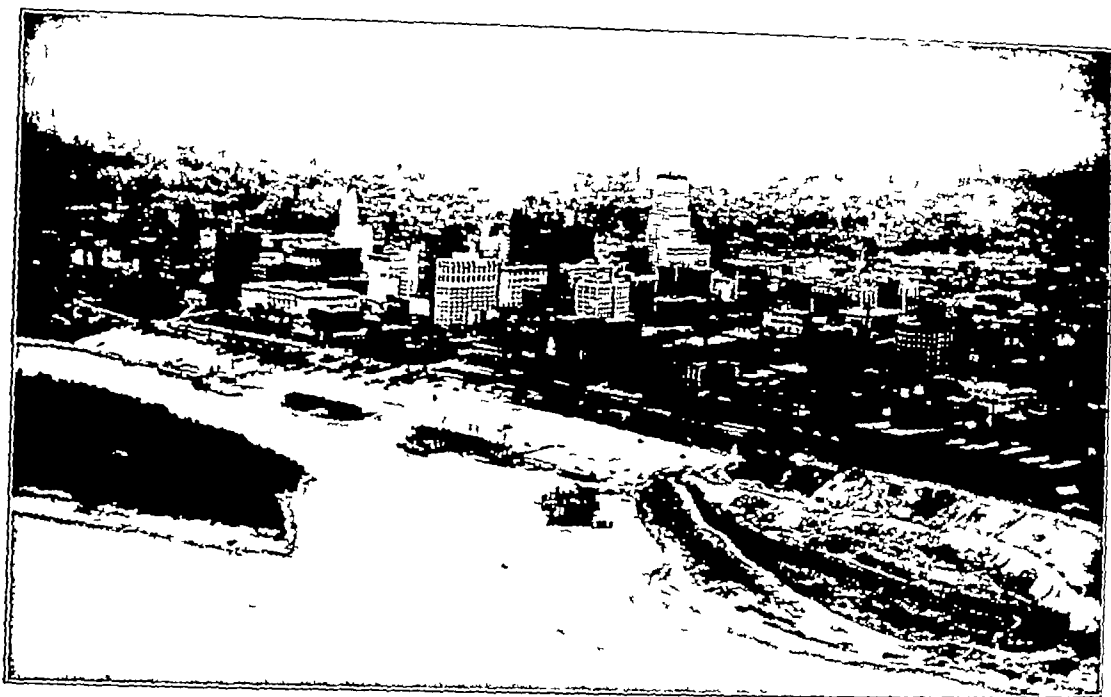
Single	Double	Twin-bedded
\$1 50 2 00	\$2 00 2 50	

WITH BATH

Single	Double	Twin-bedded
\$2 00 2 50 3 00 5 00	\$3 00 3 50 4 00 6 50	\$4 00 4 50 5 00

Hotel Parkview (200 rooms—all with bath)

Single	Rate for Two
\$2 50 3 00	\$3 00 4 00



View of Memphis, Tenn

NEXT ANNUAL MEETING

Memphis, Monday, Dec 3—Friday, Dec 7

Memphis, outstanding center in southern cotton and hardwood production (population, 261,000), dates its beginning from May, 1541, when the great De Soto first discovered the Mississippi River from the Chuckasaw Bluffs on which Memphis is built.

The site of the future city remained, however, only an Indian village and an occasional temporary Spanish or French fortification for more than two centuries—until after the American Revolution, in fact. The city itself was established in 1819 when Andrew Jackson, later to become President of the United States, James Winchester, and John Overton came from Nashville to lay out the streets of the town on land which they had recently acquired. Incorporated in the same year, the young city grew as a cotton market and as a center of distribution by virtue of its position on the Mississippi River, in the days when side-wheel steamboats were in the heyday of their usefulness. A yellow fever epidemic in the late seventies, following the Civil War and reconstruction troubles, created a pause in the city's progress. However, recovery after 1890 was rapid, as the city began its transition from

a market place for a vast agricultural area to its present position as a manufacturing and distribution center.

Memphis in 1930 still remained the world's largest inland cotton market, handling annually approximately 2,000,000 bales through the Memphis Cotton Exchange. It likewise continued in its position of world's largest hardwood lumber market and an outstanding center of the woodworking industry, including not only lumber but hardwood flooring, furniture, wooden parts for automobile bodies, automobile wheels, golf shafts and blocks, shuttle blocks, tool handles and a wide variety of allied products.

Transportation facilities which have been influential in Memphis' growth include nine railroad systems with seventeen separate radiating lines converging at Memphis, four barge lines connecting Memphis with New Orleans, St. Louis, Cincinnati, Pittsburgh, Minneapolis, and St. Paul, airline connection with New Orleans and St. Louis, nine major highway routes, which converge in Memphis to cross the Mississippi on the Harahan bridge. Five major bus line systems likewise aid transportation in Memphis.

Memphis' business district is concentrated in an area close to the Mississippi River.

ABSTRACTS OF CURRENT LITERATURE

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J E HABBE, M D , of Milwaukee, Wis	ERNST A POHLE M D , Ph D , of Madison, Wis
HANS W HEFKE, M D , of Milwaukee, Wis	CHARLES G SUTHERLAND, M D , of Rochester, Minn

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William Len Hotel (250 rooms—all with bath)

Single	Double	Twin-bedded
\$2 00	\$3 00	\$4 50
2 50	3 50	5 00
3 00	4 00	

Studio Suites, \$6 00

For Two, Three, or Four, \$7 50

Devoy Hotel (150 rooms—all with bath)

Single	Double and Twin
\$1 75 to	\$2 50 to
\$4 00	\$6 00

The Committee on Entertainment of Visiting Women submits the following tentative program

MONDAY

Afternoon—Registration

Evening—Reception, Hotel Peabody, Louis XVI Room, Music, Refreshments

TUESDAY

Afternoon—Automobile tour to Arkansas and Mississippi, visiting cotton plantations Golf, Memphis Country Club and Colonial Country Club



Dining Room Hotel Peabody, Memphis.

Hotel Ambassador (140 rooms)

Single	Double	Twin-bedded
\$1 00	\$2 00	\$4 00
1 50	2 50	

Hotel Claridge (400 rooms—all with bath)

Single	Double	Twin-bedded
\$2 50 to	\$3 50	\$4 00
3 00	4 00	4 50
	4 50	5 00
	5 00	

Hotel Adlerr (200 rooms)

Rates, \$1 50 to \$2 50 with bath

Hotel Tennessee (200 rooms)

Single	Double and Twin
\$1 75 to \$4 00	\$2 50 to \$6 00

Horseback riding, starting from Fair Grounds

Evening—Theater party

WEDNESDAY

Afternoon—Shopping tour, golf, horseback riding

Evening—Banquet, Hotel Peabody

THURSDAY

Afternoon—Automobile tour of Memphis, with visit to Brooks Memorial Art Gallery and Pink Palace Museum

Golf, horseback riding

Evening—Nineteenth Century Club—bridge and swimming

There will likely be several functions to add to the above

CONLEY H. SANFORD, M.D., Chairman

Abstracts of Current Literature

ACTINOMYCOSIS

The Roentgen Therapy of Actinomycosis R Stewart-Harrison *Röntgenpraxis*, March, 1934, 6, 180-184

Quoting the results of roentgen therapy in actinomycosis, the author describes the technic of irradiation used in Zürich. He recommends the protracted fractionated method because of its better cosmetic results. A daily dose of 240 r is given for from five to eight times. The factors are 60 cm distance, a filter of 1.3 mm copper, 170 K V, and about 2.5 to 3.5 r per minute. All cases with actinomycosis of the glands of the neck could be cured. The author hopes that the protracted fractionated method of roentgen therapy may prove to be superior to other technics in the more difficult treatment of deeply situated actinomycosis.

HANS W HEFKE, M D

Generalized Actinomycosis Hans R Schinz and R Blangey *Röntgenpraxis*, March, 1934, 6, 169-172

A generalized hematogenous actinomycosis is very rarely seen, only about a dozen cases having been described. In a 13 year-old boy an infiltrative process was found roentgenologically in the right upper lobe. An atypical tuberculosis was thought of until actinomycosis was diagnosed from a biopsy of a tumor of the skin. Two months later the infiltration in the right upper lobe had progressed, there was also a milary infiltration in the left lung which could not be differentiated from a milary tuberculosis. At autopsy a chronic indurative actinomycosis was found in the right upper lobe, which had perforated into the superior vena cava and had led to a milary dissemination of the actinomycosis in the lungs, kidneys, bones, muscles, and skin.

HANS W HEFKE, M D

APPARATUS

Investigations on Light Dosimetry I—The Photo-electric Cell W Friedrich and R Schulze *Strahlentherapie*, 1934, 50, 369-398

The authors undertook a systematic analysis of the photo-electric cells available for measuring light, and found a lack of uniformity in response and of reproductivity. After a thorough experimental study they succeeded in constructing cells which answered all necessary requirements. The method of construction is given in detail in the paper.

ERNST A POHLE, M D, Ph D

Fundamental Considerations in the Use of the Body Cavity Tube. W Schaefer and E Witte *Strahlentherapie*, 1934, 50, 579-596

In previous communications the authors have described the construction and use of an x-ray tube which may be inserted into the body cavities. This technic permits the application of high doses to the tumor and, at the same time, protection of the surrounding tissues. Further details as to the proper treatment technic are given in this article, with charts showing the distribution of radiant energy in the body. A few illustrative case reports of patients with genital carcinoma are appended.

ERNST A POHLE, M D, Ph D

"Shadowless" Sphere Ionization Chambers E Miehlnickel and B Rajewsky *Strahlentherapie*, 1934, 50, 499-515

The authors developed a small ionization chamber of spheric shape which is attached to an amber rod and absorbs, therefore, very little radiation. When submerged in water and radiographed it is practically "shadowless." The construction of the chamber and the process of manufacturing are described in detail as well as numerous tests that show that with proper dimensions of the inner electrode the r unit can be measured directly with this new chamber.

ERNST A POHLE, M D, Ph D

THE APPENDIX

Post-appendicitic Abscess Demonstrated on Roentgenograms F W Schembra. *Röntgenpraxis*, March, 1934, 6, 167-169

Pertyphilitic abscesses after appendicitis may usually be demonstrated easily on roentgenograms. They cause a round, sharply defined filling defect in the cecum without any changes in the mucosa and are always seen in the median aspect of the cecum. Another group of abscesses is in direct communication with the cecum (by perforation). The contrast material is then seen to leave the cecum and is found either in the pelvis or even in the muscles of the thigh or as a paranephritic abscess. In such instances the differential diagnosis from tuberculosis, carcinoma, and actinomycosis has to be made.

A case is described in which the barium mixture left the cecum on its lateral aspect and filled a large irregular cavity which extended into the muscles of the thigh. Operation and autopsy confirmed the diagnosis of post appendicitic abscess.

HANS W HEFKE, M D

The Appendix Morphologically Considered Rich and A Rendich and Bernard Ehrenpreis *Am Jour Roentgenol and Rad Ther*, December, 1933, 30, 791-796

Out of an unselected series of 141 routine gastro intestinal studies the appendix was visualized in 72 per cent. By further study that is after the barium clisma after evacuation of, or 6 or 24 hours after the

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proximately 50 per cent of all cases and is the most remarkable advance made thus far in the treatment of pulmonary tuberculosis. It has undoubtedly considerably improved the prognosis of certain very common forms of this disease that formerly were regarded as invariably hopeless. Total collapse was first practised in 1884, as time went on clinical experience forced the conclusion that absolute immobilization of the entire lung was not essential to healing. Partial collapse, or hypotensive pneumothorax, that accompanied by low manometric readings or negative pressure, took root and operators soon applied this newer conception in their practice. With inevitable refinements and developments in technic, this became the selective collapse of to-day. The primary object of selective collapse is to maintain uniformly and continuously complete collapse of the diseased part of the treated lung and at the same time to permit full function of the healthy part.

The mechanics are discussed in detail. Selective collapse has greatly widened the indications for pneumothorax therapy and has made it possible for patients with extensive bilateral disease to participate in its benefits. It has reduced the incidence and seriousness of pleural effusions and is undoubtedly the procedure of choice. Simultaneous bilateral pneumothorax is applicable only in a limited number of cases, and when applied judiciously the results are satisfactory. In selected cases there need be no dyspnea or other signs of discomfort. In some instances the patients can be self supporting while under treatment and within reasonable limits lead normal active lives. One should consider carefully the advantages of alternating successive pneumothorax and of pneumothorax on one side and phrenic evulsion combined with scalenotomy on the other. Alternating, or successive pneumothorax, is the successive collapse of first one lung and then the other by artificial pneumothorax. This is especially indicated in patients who develop contralateral disease during pneumothorax treatment or who have bilateral disease equally distributed when first seen.

CHARLES G. SUTHERLAND, M.D.

CONTRAST MEDIA

Lipiodol in Bronchography. Its Disadvantages, Dangers, and Uses. J. Burns Amberson, Jr. and H. McLeod Riggins. *Am Jour Roentgenol and Rad Ther*, December, 1933, 30, 727-746.

While the use of lipiodol for bronchography often makes possible the obtaining of important diagnostic information which can be gained by no other means, its indiscriminate use in poorly selected cases may be attended by very serious and even fatal after-effects. In any case with acute or subacute inflammation of the lungs or bronchi, with or without fever, the procedure should be postponed until the inflammation has subsided. It is unsafe to use lipiodol in the patient with a weak myocardium because of the dyspnea and pulmonary edema which may follow the instillation of the oil. Where there is extensive emphysema and pulmonary fibrosis, the procedure should be done with the

greatest of caution because of the danger of cardiac failure. Bronchography should be dispensed with as much as possible in the chronic asthmatic. In all cases in which there is much expectoration, the bronchi should be drained posturally as completely as possible, a thorough cleansing of the mouth and throat tissues be performed before the oil is instilled, and routinely the oil should be promptly drained by postural method, rather than by coughing, after the necessary film and fluoroscopic studies have been made. In the authors' service at Bellevue Hospital, the procedure is performed in less than 1 per cent of the tuberculous patients and in approximately from 10 to 15 per cent of the non-tuberculous ones. The injection is ordinarily done by the supraglottic route, using a syringe and laryngeal cannula after previously giving codeine sulphate, from 0.5 to 1 gram, and sodium amytal, 3 grams by mouth, and applying 4 per cent aqueous cocaine hydrochloride to the pharynx and pillars. It is very preferable to use the lipiodol at a temperature of from 67 to 75° F rather than to warm it, because when the oil flows too freely it tends to enter the terminal air sac in too large quantities, thereby being retained undesirably long in areas in which its beneficial effects are very doubtful. A number of cases are reported showing the bad results which may follow this diagnostic procedure, these being, on the one hand, in the nature of dissemination or aggravation of infectious processes already present in the chest, and, on the other hand, of sudden upset of respiratory or cardio-respiratory function.

J. E. HABBE, M.D.

CYSTICERCOSIS

Extensive Calcified Cysticercosis in the Human Body. Kurt Kremser. *Röntgenpraxis*, May, 1934, 6, 300-304.

Calcified cysticerci have a typical roentgenologic appearance. They have a length of up to one centimeter, are oval or spindle shaped, and their axis is parallel to the course of the muscle fibers. Quite often they have been accidentally discovered during a roentgen examination. The shadows of a calcified trichinosis are much smaller. In the case reported by the author the general symptoms of loss of weight, malaise, rheumatic pains, etc., pointed to a toxic action caused by the generalized infestation which could be demonstrated roentgenologically.

HANS W. HEFKE, M.D.

DENTAL RADIOGRAPHY

Roentgen Therapy of Parodontitis. K. Staunig. *Strahlentherapie*, 1934, 50, 677-682.

In this paper the author relates in detail the technic of irradiation as developed by him in the treatment of parodontitis (see also *Strahlentherapie*, 1934, 50, 453). As a rule, three fields are used and the angles of incidence of the central ray correspond to those customary in radiography of the teeth. A filter of 0.3 mm Zn + 2.0 Al is inserted and doses of from 4 to 5 H are given.

clysmas, or after sediment mixture ingestion following catharsis this percentage was increased to 90 per cent. Non visualization may be on a purely physiological basis (appendix having filled and emptied between observations), or due to obstruction of the lumen caused by the following conditions: normal appendiceal feces, spasm at the ostium or possibly of the shaft, pathologic obliteration of the lumen. The important signs of pathology are unquestionable tenderness on palpation over the visualized appendix, reflex phenomena of spasm elsewhere along the alimentary tract, and undoubted fixation of shaft or tip. The authors made careful studies of both the normal and pathologic appendix by radiographing the part after having injected it with barium following its surgical removal, and also, by the study of similarly prepared appendices in Ringer's solution under the influence of 1-1000 pilocarpine solution. They conclude that there is often a recognizable difference of the barium shadow in normal and pathologic cases which seems characteristic of the underlying pathologic state of the appendiceal wall.

J E HABBE M D

BONE DISEASES (THERAPY)

Osteitis Deformans (Paget) and Diabetes Insipidus. O Rummert. Fortschr a d Geb d Röntgenstrahl, 1934, 49, 85-90.

A case of osteitis deformans complicated by diabetes insipidus is reported which responded well to hypophyseal medication. An etiologic relationship between Paget's disease and hypophyseal dysfunction is assumed. It is also stated that sparing of preparations of hypophysis to the nasal membranes is the most satisfactory mode of administration over long periods.

H A JARRE M D

BREAST

Calcareous Deposits in the Lactiferous Tubules of Both Breasts. R Finsterbusch and F Gross. Röntgenpraxis March 1934, 6, 172-174.

All breast tumors are examined roentgenologically at the Surgical Clinic of the University of Leipzig. In a woman with a carcinoma of the breast a heretofore not described calcification of the lactiferous tubules was seen. The roentgenogram of both breasts showed multiple round or oval and elongated shadows of the density of calcium. From their distribution and arrangement, calcification of the ducts was diagnosed roentgenologically and confirmed after amputation of one breast. The patient had never had a mastitis. The authors believe that the calcifications took place because none of the nine children had been nursed by the mother and that stagnation of the secretion, so often repeated, caused the deposit of lime salts.

HANS W HEFKE, M D

CANCER (THERAPY)

Treatment Methods at the Women's Clinic in Erlangen for Roentgen Therapy of Carcinoma of the

Female Genital Organs. Franz Wittenbeck. Strahlentherapie, 1934, 50, 399-427.

The technic employed at the Women's Clinic at the University of Erlangen as developed by Wintz in the treatment of carcinoma is described by the author. Before administering roentgen therapy copper iontophoresis is used, this serves not only as a disinfectant but also increases the secondary radiation and is supposed to have a direct effect on carcinoma cells. In conclusion, the author states that an improvement of the results can be obtained only by treating carcinoma in its early stages.

ERNST A POHLE, M D, Ph D

The Seminoma (Embryonic Carcinoma) of the Testicle and the Ovary. Antoine Bécélère. Strahlentherapie, 1934, 50, 597-610.

The pathologic aspect of embryonic carcinoma of the testicle and ovary is discussed briefly, followed by a review of the literature concerning radiation therapy in these highly radiosensitive tumors. The latest investigations of Ferguson (Memorial Hospital) are quoted freely. The author's indications for irradiation are, in general, in agreement with those recognized in this country.

ERNST A POHLE, M D, Ph D

Lymphoepithelial Tumors (Transitional Cell Carcinoma). Emil Maier. Strahlentherapie, 1934, 50, 611.

Following a discussion of the pathologic and clinical aspects of lymphoepithelioma (transitional cell carcinoma), the author emphasizes the radiosensitivity of these tumors. If properly treated according to the Coutard method the percentage of three year cures varies from 45 to 55 per cent.

ERNST A POHLE, M D, Ph D

Further Contribution to the Roentgen Therapy of Carcinoma at Short Focal Skin Distance. H Chaoul. Strahlentherapie, 1934, 50, 446-452.

The author gives further data concerning the method of irradiation at short focal skin distance (60 K V, 0.2 mm Cu, 5 cm FSD). The preliminary results are encouraging, 90 per cent of 103 tumor cases of various types are free from symptoms for one to three years. He relates the history of a man with a carcinoma of the rectum the size of an apple. A colostomy was done and the coccyx and sacrum resected to render the tumor accessible for direct irradiation. Within a period of four weeks 9,200 r were given. Six weeks later the rectum was completely removed and histologic study did not show a trace of carcinoma.

ERNST A. POHLE, M D, Ph D

CHEST, COLLAPSE THERAPY

Clinical Types of Therapeutic Pneumothorax and Their Significance. J W Cutler. Jour Am Med Assn, July 14, 1934, 103, 81-83.

Artificial pneumothorax is practised to-day in ap-

right iliac fossa, and on the fourth at the hepatic flexure of the colon. On the fifth the patient was lipothymic, with rapid pulse and cold sweats, but in the early hours of November 6 the pin was passed without any trouble.

These authors state that the surgeon's best policy is one of watchful expectancy, always remembering the size of the various portions of the duodenum, and if in doubt, waiting rather than operating. Purges and massage should be avoided. Feeds of wholemeal bread, boiled lentils, peas and beans (dried) with mashed potatoes can be given. Once the duodenum is passed all fears may be put aside, but it should not be forgotten that this organ in a young child is fixed and will measure 15 centimeters.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Layer formation of Bile as an Expression of Muscular and Resorptive Function of the Gall Bladder, Also a Contribution to Accelerated Cholecystography. A. Bernstein. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, 49, 68-84.

On the basis of roentgenologic observation, physiologic information, and recent literature, the following cholecystographic technic was devised. Cleansing enema the preceding night, at 7 A.M., two raw egg-yolks, 8.30 A.M., 0.001 g. atropine subcutaneously, 9 A.M., 4 g. tetraiodophenolphthalein dissolved in 40 ccm. of 40 per cent glucose solution intravenously. Roentgenograms show highest concentration two to three hours after injection, in normal individuals (Dye is to be dissolved in small amount of water, filtrated, sterilized, then added to sterile glucose solution and mixed. No sterilization after mixing as it will produce decomposition and precipitation).

Roentgenograms are made in upright and prone positions. The former regularly show layer formation of bile, with iodine-containing bile in fundus. Very rarely does complete evacuation of bile take place after ingestion of food. Newly inflowing liver bile must be specifically lighter than concentrated gall bladder bile.

Interesting speculations are deduced from these observations. Experiments with this technic and cholecystograms in erect posture would seem worth while.

H. A. JARRE, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

A Large Fecalith Containing Bismuth as a Complication of Hirschsprung's Disease. A. Kos. *Kovacs Röntgenpraxis*, March 1934, 6, 164-166.

Large fecaliths have repeatedly been described in the literature. They may lead to as serious complications as complete obstruction and perforation. A man 53 years old had been constipated as long as he remembered. Some years previously the roentgenologic diagnosis of megacolon had been made. The present complaints of the patient were severe constipation, loss of appetite and loss of 16 pounds in weight

during the last year. One could feel a large, slightly movable mass, the size of a child's head, in the pelvis. Proctoscopy was negative. A flat film of the pelvis showed a large, well defined opaque shadow with a concentric structure, it was surrounded by gas. The diagnosis rested between a fecalith and a large benign calcified tumor. At operation a fecalith weighing 740 grams was removed from the sigmoid. It contained a large amount of bismuth, apparently from the barium enema administered four years previously.

HANS W. HEFKE, M.D.

Contribution to the Roentgenologic Diagnosis of Sarcomas of the Small Intestines. H. J. Busche. *Röntgenpraxis*, March, 1934, 6, 141-145.

Two cases of sarcoma in the upper portions of the small intestines are described, in both of which there were roentgenologic symptoms of partial small intestinal obstruction and in one of which the filling defect could be demonstrated. Histologic examination showed a polymorphous round-cell sarcoma in both instances. It is necessary to make the examinations rather more often than in the usual case in order not to miss the lesion.

HANS W. HEFKE, M.D.

GENITO-URINARY TRACT (THERAPY)

X-ray Treatment of Diseases of the Genito-urinary System. G. Harrison. *Orton British Med. Jour.*, Aug. 25, 1934, No. 3,842, 343-346.

The author briefly reviews the general principles of x-ray therapy and discusses the treatment of diseases of the genito-urinary tract by means of the x-ray.

There is a good deal of controversy and confusion as to what is implied by a unit skin dose. The number of r units considered necessary to produce an erythema dose and the grade of erythema produced vary considerably in various clinics. The author's erythema dose consists of a dose of x-rays which, when applied to the skin of the abdomen of an adult, produces a slight redness within three weeks after the application, followed by some bronzing or pigmentation of the skin, but no desquamation. While this dose is at least 25 per cent less than that often given, the preservation of the integrity of the skin should be considered very important and the number of ports of entry increased wherever possible rather than run the risk of causing damage.

Several methods of employing irradiation therapy are available. The fractional dose, the oldest method, consists in giving fractional doses of one third to four-fifths of the unit skin dose at intervals of a few days, or a week, and keeping it up for a considerable period of time. The single massive dose method is the application in a single dose of the largest dose which the tissues will tolerate. The divided, or split, dose method is a modification of the massive dose method in which the dose is spread over an interval of time. The saturation method consists of the maintenance of the effects of the treatment by giving further daily doses after the maximum dose has been given. The

($\lambda_0 = 0.1 \text{ \AA}$) The entire treatment is administered within from ten to fourteen days using intervals of from five to seven days between fields

ERNST A. POHLE, M D, Ph D

Roentgen Therapy of Paradenitis Kurt Neugebauer and Konrad Staunig *Strahlentherapie* 1934, 50, 453-461

Roentgen therapy proved to be of benefit in cases of paradenitis. While the symptoms appeared to be more severe during the first days after irradiation, definite improvement was noticeable in the majority of cases within a week. Most striking was the improvement in patients with loose teeth. Progress studies should be made both clinically and roentgenographically.

ERNST A. POHLE, M D, Ph D

DOSAGE

The Dosis of Roentgen Rays Hermann Behnken *Strahlentherapie*, 1934, 50, 476-483

The Definition of the Absolute Unit of the Roentgen ray Dose L. Grebe *Strahlentherapie*, 1934, 50, 484-486

Both authors offer a theoretical discussion in favor of a change in the definition of the r. Behnken's new definition would mean that a dose of 1 r corresponds to the absorption of 83 ergs or approximately 2μ cal of roentgen energy in one gram of tissue.

Grebe, on the other hand, suggests that it be worded as follows: The absolute unit of the roentgen-ray dose is delivered by that amount of roentgen rays which produces in 1 c.c. of air irradiated homogeneously (0° centigrade and 760 mm Hg pressure) an ionization equivalent to 2.09 milliards of single charged pairs of ions.

ERNST A. POHLE, M D, Ph D

A Roentgen Meter for Small Intensities of Radiation Josef Frank *Strahlentherapie* 1934, 50, 687-692

The author describes a sphere shaped measuring instrument designed for the determination of small doses of roentgen rays. It is particularly fitted to test the degree of protection in x-ray laboratories since doses of 10^{-3} to 10^{-2} r per second can be measured with satisfactory accuracy.

ERNST A. POHLE, M D, Ph D

ESOPHAGUS (THERAPY)

Carcinoma of the Esophagus Treated by Radiation F. J. Clemenson and J. P. Monkhouse *Jour Laryngol and Otol* May, 1934, p. 313. Reprinted by permission from the *British Med Jour* July 28 1934 p. 15 of *Epitome of Current Medical Literature*.

The authors report the results of radon treatment of 89 cases of carcinoma of the esophagus (excluding post-cricoid growths) in the Middlesex Hospital during the years 1925-32. They suggest that this treatment may be actually harmful for these patients might actually live longer if their only treatment were preliminary removal of all teeth followed by gastrostomy. As a rule they

do not seek advice until peripheral extension of the malignant growth and early metastasis have made it impossible for the radiation to reach the outlying parts of the carcinoma with effective strength. It is even possible that there may be some danger of stimulation of the growth at the periphery, and the termination be thus hastened rather than delayed.

The mode of treatment was to perform first an esophagoscopy for diagnosis with removal of a fragment of the growth for section. The patient was then examined by x-rays to determine the length of the stricture, the Trendelenburg position being essential for this procedure, for otherwise the lower end of the stricture is not defined. From this information the dose of radon to be used and the length of the applicator were deduced. At a second esophagoscopy the radon was placed in position and left for seven days. In several cases the ulceration disappeared after this treatment but columns of cancer cells were found in the subgastric lymphatics between the muscle bundles if not also in the actual stricture substance.

The average survival period for the whole series was 5.6 months for growths in the upper part, 6.7 months the middle part, 5.4 months, and the lower part, 6.9 months. For the ten women it was 8.5 months and for the 79 males 5.2 months. The average length of the history of dysphagia was for women, 5.4 months and for men, 3.8 months women having thus a longer history and a longer survival period. A short history does not, therefore, indicate that the case can be considered early. It would seem that a preliminary gastrostomy might be beneficial especially if preceded by removal of all remaining teeth. Increasing the dose of radon was associated with an even shorter period of survival, and the optimum dose appeared to be a moderate one of about 5 mc. to the inch screened by 0.5 mm of platinum. The authors add that deep x-ray therapy may be a more promising line of treatment.

FOREIGN BODIES

Ingestion of Foreign Bodies. Clinical radiological Considerations. Marcelo H. Moreau and Oscar F. Noguera. *Semana Médica* April 26 1934, p. 1318. Reprinted by permission from the *British Med Jour* July 28 1934, p. 14 of *Epitome of Current Medical Literature*.

The authors, collating their experience with that of surgeons all the world over, unhesitatingly condemn precipitate operation in the above condition, and stress the importance of frequent screening, "which should never be omitted in cases about to be operated upon after the anesthetic has been administered as it has been proved that a foreign body long stationary in the stomach, has frequently passed through the pylorus while the patient is going under." One of the three cases they report was a child of 20 months who at noon on November 1 swallowed a slightly bent tie pin 5.5 cm long with a small glass ball at one end. On screening at 3 p.m. the pin was seen to be in the stomach but at 3.30 p.m. gastrostomy disclosed an empty stomach. On November 3 the pin was seen in the

tion again becomes impossible. One important advantage of routine film study is the detection of bone lesions which otherwise may remain hidden beneath superficial disease of the synovia or even beneath normal tissues.

J E HABBE, M.D

THE OVARIES

Formation of Hydrometra Following Post operative Radium Treatment in a Case of Ovarian Carcinoma
E Vogt *Strahlentherapie*, 1934, 50, 683-686

A woman of 33 years of age was seen in June, 1931, with a tumor the size of a child's head located to the right and posterior to the uterus. Laparotomy revealed a carcinoma in both ovaries. X-ray therapy was given two weeks after operation and in October, 1931, radium was applied (1,800 mgh intra uterine and 400 mgh in the vagina). Roentgen therapy was also given. The patient remained well until August, 1933, at which time the abdomen was considerably enlarged and operation revealed a hydrometra containing 200 cc of fluid. There were no metastases.

ERNST A. POHLE, M.D., Ph.D.

RADIATION EFFECTS

The Role of the Sympatheticus in Radiation Therapy
Walter Altschul *Strahlentherapie*, 1934, 50, 669-676

Dermatologists years ago suggested irradiation of the spinal cord in the treatment of certain skin disorders. We believe now that the effect is due to an action of the radiation on the sympathetic nervous system. The results obtained by irradiation in gastric and duodenal ulcer, in bronchial asthma, and in certain endocrine disturbances may also be explained by the same mechanism.

ERNST A. POHLE, M.D., Ph.D.

RADIOLOGY, PRACTICE OF

The Radiology of Living Anatomy
James F. Brailsford *British Med Jour*, June 2, 1934, No 3,830, 984-986

The author stresses the great importance of including a course of 'radiology of living anatomy' in the curriculum of medical students. This course of instruction should begin with a thorough study of roentgenograms taken in standard positions, and of normal structures at different periods from infancy to old age. In this manner only will sufficient knowledge of the variations observed in normal anatomy be obtained such as is so necessary for correct interpretation of roentgenograms.

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The essential part of the study of the gastro-intestinal tract consists of the fluoroscopic examination after the administration of barium sulphate. It is important that a thorough preliminary roentgenologic study be made of the abdomen before the administration of the opaque medium, to determine the presence of abnormal shadows. The gall bladder and biliary tract are best studied after the administration of the dye. Misinterpretation of areas of gas in the duodenum for negative shadows due to gallstones should be avoided. Serial roentgenology is an extremely valuable method of examination which should be employed when indicated. The interval of time between roentgenograms varies from a fraction of a second in the case of a gastro-intestinal study to a month or several months in the study of the development of the skeleton.

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J. N. ANÉ, M.D.

The Future of Radiology as a Medical Specialty
Henry K. Pancoast *Am Jour Roentgenol and Rad Ther*, December, 1933, 30, 711-717

The requirements of specialization in radiology are probably greater than in any other medical specialty with the exception of the major branches of medicine and surgery. The purely technical phases of radiologic practice must often be delegated to the technician if the radiologist is to give adequate time to interviewing patients, roentgenologic interpretation, consultations, planning treatments, working out new technical procedures, teaching, writing and keeping up with the endless literature of the subject. For the elevation of the standards of radiologic practice, all should have a certain minimum of clinical experience as a background,

protracted fractional dose technic (Contard), according to Schumacher, has allowed him to give from 2,000 to 2,500 r to the bladder and intestines with little reaction of these organs

The author is of the opinion that when it is decided to give large doses they should be so regulated as to avoid as much as possible, any lowering of the general resistance of the patient. To accomplish this the following are considered important. The ports of entry should be as small as is compatible with efficient radiation, the shortest route to the lesion should be chosen, the patient should be protected from scattered radiation, and, if on a trial dose there is any upset, the intervals between the doses should be increased from one to two, three or more days, regulating the dose accordingly, rather than risk lowering of vitality

In the irradiation treatment of kidney conditions it is believed that no attempt should be made to give massive doses. In the application of divided doses the effect on the patient should be carefully watched. While surgery is believed to be the method of choice in growths of the bladder, the author believes that in the case of growths unsuitable for operation, or in recurrent tumors, x ray treatment should be tried. He suggests spreading the dose over a period of from ten days to two weeks

Simple enlargements of the prostate are treated through six ports of entry, three anterior and three posterior. Malignant prostates are treated through the six fields, with the addition of a perineal field, using an erythema dose to each field. Growths of the testicle should be treated by surgery followed by post-operative radiation. Tuberculous epididymitis responds favorably to small doses of x rays

J N ANÉ, M D

Technic and Results of Vesiculography. A Puigvert Gorro. Jour d'Urol, March, 1934, p 193. Reprinted by permission from British Med Jour, June 30, 1934, p 102 of Epitome of Current Medical Literature.

The author points out the difficulty previously experienced in obtaining an x-ray exposure of the seminal vesicles which have been visible only in cases in which there is a calculus or cystic lesion, or in which a tumor is in the process of calcification. In order to obtain a good result it is necessary to inject a contrast medium, and it has been found that neo-iodipin answers this purpose. It is neither toxic nor painful—even if remaining for some time in the seminal vesicles—while good aseptic results are obtained. It is possible to fill the vesicles by four different methods: by catheterization of the ejaculatory ducts by urethros copy, by transrectal or perineal puncture of the seminal vesicle, by subcutaneous puncture of the vas, or by puncture of the vas by the scroto-ingual route. Of these methods the first is often unsuccessful, the second and third are uncertain and dangerous and it is thus by the last method that good results have been obtained. The success of the procedure depends on the technic, which the author fully describes and illustrates. The operation is carried out under local

anesthesia, a 10 per cent solution of novocain being used. An incision is made at the root of the scrotum, and the opaque liquid is injected into the vas until the patient desires to urinate thus showing the passage of the fluid from the vesicle into the prostatic urethra and into the bladder. This usually occurs after from 2 to 3 c.c. has been injected. The incision is closed, and the patient expels any surplus fluid. The x ray film can then be taken with the patient on his back. The fluid injected often remains in the vesicular cavity for several days, or even weeks, without causing discomfort.

By this means it is possible to obtain an accurate diagnosis in cases of malignant tumors of the prostate, retrovesicular and retroprostatic tumors, and in chronic inflammatory conditions of the vesicles.

HAY FEVER

Further Results in Roentgen Therapy of Hay Fever. H Th Schreus. Strahlentherapie, 1934 50, 462-467.

The author recommends from 15 to 20 per cent H E D every ten to fourteen days during the hay fever season (6 X 8 cm field, 0.5 mm Cu applied over the nose). During the period from 1930 to 1933 48 patients were treated but only 35 answered the follow up questionnaire. Six were well, nine considerably improved, seven somewhat improved while the remaining thirteen did not receive any benefit from the treatment.

ERNST A POHLE M D, Ph D

KNEE JOINT

Tuberculosis of the Knee Joint. A Comparison of its Morbid Anatomy with its Roentgenological Manifestations. Ralph K. Ghormley, B R. Kirklin, and Ernest A. Brav. Am Jour Roentgenol and Rad Ther, December 1933 30, 747-755.

This paper is based on a study of the pathologic material obtained from 113 knee resections and 7 leg amputations, from which group of cases there were 77 with available roentgenogram studies. In the series of 77, 65 were tuberculous lesions and 11 were non-tuberculous arthritides. Correlation of the roentgenologic and pathologic findings disclose the fact that in the very early cases the x ray appearances of the knee are apt to be normal. Later on as the disease progresses, the x-ray becomes frankly abnormal the changes being bone atrophy, haziness of joint structures, marginal erosion of bone thinning or interruption of articular cortex, at times bone abscess or sequestrum formation, and late preservation of joint cartilage. Differentiation between tuberculous and non tuberculous disease in the knee joint is often impossible, although early complete destruction of joint cartilage a wider involvement of bone than the margins of the areas of pressure, articular lipping, non-existence of abscesses tendency toward generalized or spotted hypertrophy are the appearances one more regularly encounters in non tuberculous infection. In the late stages of each type of involvement the x ray differentia-

tion again becomes impossible. One important advantage of routine film study is the detection of bone lesions which otherwise may remain hidden beneath superficial disease of the synovia or even beneath normal tissues.

J E HABBE, M.D

THE OVARIES

Formation of Hydrometra Following Post-operative Radium Treatment in a Case of Ovarian Carcinoma
E Vogt *Strahlentherapie*, 1934, 50, 683-686

A woman of 33 years of age was seen in June, 1931, with a tumor the size of a child's head located to the right and posterior to the uterus. Laparotomy revealed a carcinoma in both ovaries. X ray therapy was given two weeks after operation and in October, 1931, radium was applied (1,800 mgh intra-uterine and 400 mgh in the vagina). Roentgen therapy was also given. The patient remained well until August, 1933, at which time the abdomen was considerably enlarged and operation revealed a hydrometra containing 200 c c of fluid. There were no metastases.

ERNST A. POHLE, M.D., Ph.D.

RADIATION EFFECTS

The Role of the Sympatheticus in Radiation Therapy
Walter Altschul *Strahlentherapie*, 1934, 50, 669-676

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be particularly well informed in the field of pathology, and finally familiar with both the wide range of normal appearances and the characteristic and atypical appearances of the numerous disease processes wherein the x ray is useful. Radiologists offering post graduate education should be morally bound to select for their students only those with desirable personalities and high abilities. Anatomists, pathologists, physicists, and research workers, as well as clinicians, have aided greatly in the upbuilding of this specialty.

J E HABBE, M D

Influences Affecting the Future of Roentgenology
John T Murphy. *Am Jour Roentgenol and Rad Ther*, December, 1933, 30, 718-722

In the opinion of the author, roentgenology is at a fork in the road. It may be absorbed in the general practice of medicine, it may be split up into a number of specialties or it may remain as a separate medical specialty. As much effort should be expended to-day to keep roentgenology a separate specialty as has been used in the past to advance it scientifically. Roentgenology, which to day fills an important place in the practice of medicine, will in the future suffer scientifically unless it is treated by the other specialties on an equal scientific and economic basis. The recent organization of the Board of Radiologic Examiners should help to elevate the standards of roentgenology in the future.

J E HABBE, M D

RADIUM

The Effect of Radium Emanation Treatment on the Alkali Reserve of the Blood. Siegfried Becker. *Strahlentherapie*, 1934, 50, 468-470

The author studied the alkali reserve of the blood in 15 patients, three of whom received the radium emanation *per os*, two *per enema*, and ten in the form of inhalations. He noticed a definite decrease of the alkali reserve 13 times, the average drop being 10 per cent. One case did not show any changes and in one a slight increase occurred. This drop lasted several weeks (four weeks in the average case), but returned to normal after that time. No correlations between subjective reaction and the degree of change in the alkali reserve could be found.

ERNST A. POHLE, M D, Ph D

The Effect of Intravenous Radon Injection on the Blood. M Nemenow and R Gurewitsch. *Strahlentherapie*, 1934, 50, 693-704

The effect of intravenous radon injection on the blood was studied in 25 rabbits. Blood counts were done from three to seven times in each animal before injection. The normal values were from 3,500,000 to 4,500,000 red blood cells, from 45 to 70 per cent hemoglobin from 7,000 to 12,000 leukocytes. From 10 to 435 mc were given at a single sitting—it appeared that from 130 to 150 mc were fatal for an adult rabbit.

The number of leukocytes dropped after the injection of from 20 to 30 mc. of radon the drop beginning from thirty minutes to one hour after the injection. An occasional leukocytosis is seen from one to two hours, and sometimes twenty four hours, after the injection. If given moderate doses the lowest level of leukocytes is reached after from four to six days and returns to normal within from twelve to twenty days. Studies of the differential count showed that the decrease of the leukocytes was due to the drop in the number of lymphocytes. The process of regeneration manifests itself by the appearance of large and medium sized lymphocytes in the blood stream. The number of the red blood cells showed no significant changes. Histologic examination of lungs and kidneys did not reveal definite injuries.

While the use of intravenous radon injection in the treatment of malignant tumors seems therefore, rather doubtful, it may have possibilities in the treatment of leukemia, particularly of the lymphatic type.

ERNST A. POHLE, M D, Ph D

Observations Concerning Unequally Filled Radium Preparations. A Pickhan and K G Zimmer. *Strahlentherapie*, 1934, 50, 516-519

A number of tests on radium needles and radium screens showed that very often the radium salt is not evenly distributed throughout the applicator. Photographic tests are, therefore, suggested to check up on the distribution of radium salt in radium applicators to assure proper dosage.

ERNST A. POHLE, M D, Ph D

THE SPINE

Roentgen Therapy in Spondylarthritis Ankylopoetica. F Haenisch. *Strahlentherapie*, 1934, 50, 623-640

The author treated 13 cases of spondylarthritis ankylopoetica by radiation therapy. Technic HVL in Cu, 0.9 mm, field 10 × 12 or 10 × 15 cm, 5 times 130 r per field with an output of from 28 to 35 r per minute, intervals between fields from 5 to 10 days. Series may be repeated after six months. Ten patients responded well to the treatment.

ERNST A. POHLE, M D, Ph D

THE THORAX

An Unusual Observation on a Spontaneous Pneumothorax. G F Haenisch. *Röntgenpraxis*, March, 1934, 6, 147-150

During a fluoroscopic examination of a chest on account of indefinite complaints a complete pneumothorax was discovered in deepest expiration—it disappeared again in inspiration a phenomenon which could be duplicated at will. Films taken in inspiration and expiration showed also the same picture. Such an occurrence has to the author's knowledge never been described in the literature. An explanation might be that a small pneumothorax had been caused by over exertion and that it surrounded the lung in a thin layer.

and was not visible during normal respiration. The unusually marked decrease in the pleural space on deep expiration must have caused a complete collapse of the lung even by a comparatively small amount of air in the pleural cavity. It seems advisable to examine patients with a suspected pneumothorax in deep expiration also.

HANS W. HEFKE, M.D.

TUBERCULOSIS, PULMONARY

Failures of Roentgen Sterilization in Cases with Tuberculosis of the Lungs. F. v. Mikulicz-Radecki. *Strahlentherapie*, 1934, 50, 658.

An analysis of the records of 16 women sterilized by roentgen rays showed that from 270 to 329 r effective in the ovaries were necessary to produce results. The age has a definite influence on the doses required— younger women need more radiant energy. A follow up showed that in three cases pregnancies occurred, at eight months, two years, and six years, respectively, after irradiation. Since this is a very undesirable occurrence, the author recommends the use of operative sterilization as the method of choice.

ERNST A. POHLE, M.D., Ph.D.

TUMORS (DIAGNOSIS)

The Diagnosis and Treatment of Intrathoracic Tumors of Neural Origin. M. Makkas. *Brun's Beitr. z. klin. Chir.*, March 14, 1934, p. 276. Reprinted by permission from the *British Med. Jour.*, June 30, 1934, p. 102 of *Epitome of Current Medical Literature*.

The author gives an account of two personal cases and 26 from the literature of operation for intrathoracic neural tumor, comprising ten ganglioneuromas, nine neurofibromas, eight neurinomas, and one sympatheticoblastoma. With the exception of one neurofibroma which had become sarcomatous, all were benign. All but one were found in the posterior mediastinum (usually high up), and three out of four affected females. There was no special age incidence except that ganglioneuroma in the great majority of cases occurred below the age of 20. The source of the tumor was frequently undetermined but appeared as a rule to be the sympathetic cord or an intercostal nerve. The largest diameter of the tumors ranged from 3 to 20 cm. Clinically a long history (two to twenty years) of slight and indefinite symptoms was usual—slight pain, dyspnea or dry cough. Intercostal neuralgia was reported in two cases only. Physical signs of dullness and impaired air entry led to suspicion of chronic pulmonary or pleural inflammation in most cases, but diagnosis was sometimes aided by detection of a supraclavicular extension of the tumor (four cases)

or a unilateral ptosis and myosis pointing to sympathetic palsy.

In no case was diagnosis made before radiography, but in no case did this fail to show the tumor, however, it was not seldom regarded as being probably a dermoid or hydatid cyst. Differential diagnosis from malignant tumor is not long difficult. From a dermoid cyst, which also has a sharp, rounded outline, neurogenous tumors are distinguished by their occurrence in the posterior mediastinum, from a hydatid cyst, by their broad inner margin, flat or non-concave internally toward the vertebral axis, and by the negative Casoni reaction.

At operation, posterior mediastinotomy is preferable, the tumor shells out without difficulty, and serious hemorrhage has not been noted. Opening of the pleural cavity is usually unavoidable. Sauerbruch recommends that in operations on tumors of sympathetic origin a posterior portion should be left behind—otherwise a lethal tachycardia may occur. The mortality in this collected series was 32 per cent, and pleuro-pulmonary complications followed in about one half.

The Roentgenologic Examination of the Osseous Orbit. Georg Steiner. *Röntgenpraxis*, March, 1934, 6, 150-157.

Pathologic changes of the osseous orbit are often very difficult to diagnose roentgenologically, especially in the early stages. Normal differences in structure and opacity are confusing. A radicular cyst is described which elevated and eroded the inferior wall of the orbit. An hemangioma which extended toward the median fossa and destroyed portions of the hard palate had also raised the floor of the orbit and led to destructive changes in it. Fractionated roentgen therapy improved the condition markedly. The case of a questionable fracture of the ala magna is described in detail and the difficulties in diagnosis are pointed out.

HANS W. HEFKE, M.D.

The Significance of the Displaced Calcified Pineal Body for the Roentgen Diagnosis of Brain Tumors. E. Woerner. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1934, 49, 499-512.

Observations of Vastine and Kinney are extensively quoted. On their basis two cases of brain tumor were successfully localized. A third case of displacement by cicatricial retraction following trauma by a shell fragment is also shown.

H. A. JARRE, M.D.

THE TWENTIETH ANNUAL MEETING

OF THE
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* The Western lines have advised that reduced fares will be in effect from Winnipeg and certain points in British Columbia.

RADIOLOGY

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NO 5

ROENTGENOLOGIC STUDY OF THE DUODENUM AFTER INTUBATION AND OBTURATION¹

By PAUL H. SHIFFER, M.D., *Stroudsburg, Pa.*

From the Gastro-intestinal Section of the Medical Clinic and the Radiological Clinic of the
Hospital of the University of Pennsylvania

INTRODUCTION

ROENTGENOLOGIC investigation of the duodenum as now practised usually leads to the accurate diagnosis of such lesions of that organ as ulcer, duodenitis, diverticulum, adhesions, obstruction, or tumor, but the observations of some of these lesions are not quite so uniformly trustworthy as are those based on a similar study of the stomach. Not infrequently one has to be content with the demonstration of duodenal cap irregularity without commitment as to its cause—ulcer, adhesions, or spasm. Such uncertainty rarely exists regarding gastric defects chiefly because the stomach can be well filled with an opaque medium which allows its outlines under tension to be clearly visualized on the fluoroscopic screen and on films. Such favorable conditions in the duodenum are not uniformly obtainable because the opaque substance administered orally and first filling the stomach, reaches the duodenum slowly and in small masses that are very readily passed on to the jejunum. For this rea-

son the duodenum is often not well filled even for a short time. Furthermore, the examiner is often unable to obtain a complete image of the duodenum, even when well filled, because the shadow of the barium-containing pyloric end of the stomach obscures it.

Frequent attempts have been made to develop a technic that would overcome these obvious difficulties in the roentgenologic diagnosis of duodenal lesions, but none has obtained practical recognition or acceptance. The recent development of a double-lumened intestinal tube in this section of the Medical Clinic by Miller and Abbott (1) suggested to me that such a tube might be employed in a practical way to aid in the diagnosis of certain obscure duodenal lesions. It will be noted below that somewhat similar methods of study have been referred to by various writers, but I was not aware of these described technics when this work was undertaken, also, apparently no one of them has been subjected to extensive clinical test or is sufficiently simple in application to justify its routine use in obscure cases.

Literature—The introduction of an opaque substance by tube directly into the duodenum for its roentgenologic visualization has been practised many times by Einhorn (2), David (3), Wheelon (4),

¹ Thesis submitted to the Faculty of Internal Medicine of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science (M.Sc. (Med)) for graduate work in Gastroenterology.

Palesfki (5), Buckstein (6), Saracom (7), and Castex (8). Such a technic has an advantage over the usual method in that it renders the entire organ visible, but it often fails to clarify the diagnosis because the mixture is not retained in the duodenum long enough to allow one to make a satisfactory examination. This is particularly true if the lesion causes irritability or spasm.

An advance was made by Cole (9), who, using a single Einhorn pyloric dilator passed to the distal portion of the duodenum, caused a blockage in the organ by distention of the balloon at the end of the tube and then gave an opaque meal by mouth. He suggested that a double tube might be used, a blockage produced by a bag connected with one lumen, and then a bismuth or barium mixture introduced proximal to the balloon by the other lumen. In 1913, Einhorn (10) published an article showing that he had applied this method of study and presented a roentgenogram that illustrated an air-filled balloon in the duodenum and a bismuth-filled cap proximal to it. Van Nuys (11), in 1921, gave a preliminary report on the use of a similar technic but with a different type of tube. In 1927, Pribram and Kleiber (12) used duodenal blockage with retrograde filling by an opaque substance, and went one step farther by producing a "pneumo-duodenum" in order to secure a double contrast image. None of these authors has referred to an extensive experience with his method. Thus, although the use of a double-lumened tube to produce duodenal obstruction and to fill the duodenal cap has been used before, little evidence has been recorded of its practicability or its advantages. This paper proposes to call attention again to its value, to describe in detail a new and practicable technic, and to report observations on a number of normal and pathologic cases.

Technic—The tube which I have employed is 106 cm. in length with an outside diameter of 6 millimeters. It is divided longitudinally into two lumina by a rubber partition, one leading to a balloon (an

ordinary finger cot) at its distal end, and the other lumen to an opening just proximal to the attachment of the balloon. A duodenal bucket at the distal end of the tube over which the balloon is attached is employed for the purpose of making easier the localization of the distal end of the tube under the fluoroscope. A Luer syringe is used to inject air, usually about 40 c.c., into the balloon. The size of the balloon and the amount of air necessary to distend it are tested prior to each intubation. When the balloon is in place it is distended with air. A barium mixture is then allowed to run from a small vessel by gravity into the duodenum proximal to the balloon, the speed of flow being regulated by the height of the reservoir.

The patient is intubated after a twelve- to fifteen-hour fast. The time required for the balloon to reach the duodenum in my series of cases varied from one-half to one and a half hours. If fluoroscopic control and manual manipulation, as described by Morgenstern (13) or Rousselot and Bauman (14), are used, this time can be shortened. It is well to have an inch or two of slack tube in the stomach so that it does not hug too closely the lesser curvature of the stomach, a condition which sometimes produces nausea. The ideal place in the duodenum for the balloon to be located finally is in the third or fourth portion. If proximal to this point, it is apt to be regurgitated into the stomach when air is injected. When in the proper position the balloon is slowly inflated. A word of caution must be spoken at this point. Too much air must not be used at first or the purpose of the examination will be defeated. If enough distention is used to cause an undue stretching of the duodenal wall, violent reverse peristalsis is initiated, with regurgitation of the balloon. It is better not to demand a complete obstruction at first because the examiner does not always know when he is working in the presence of an acute lesion that may be made worse by too much distention. Caution must also be used when the barium is allowed to run in so that a

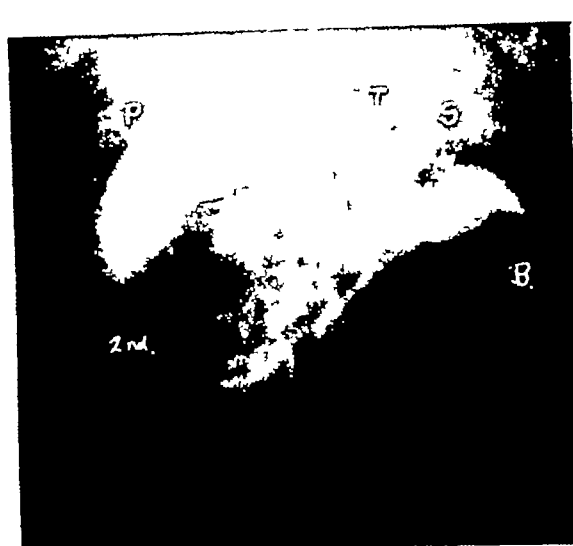


Fig 1 Intubation and retrograde filling in a normal case P, Duodenal cap T, Tube S, Stomach B Balloon distended at area of Treitz

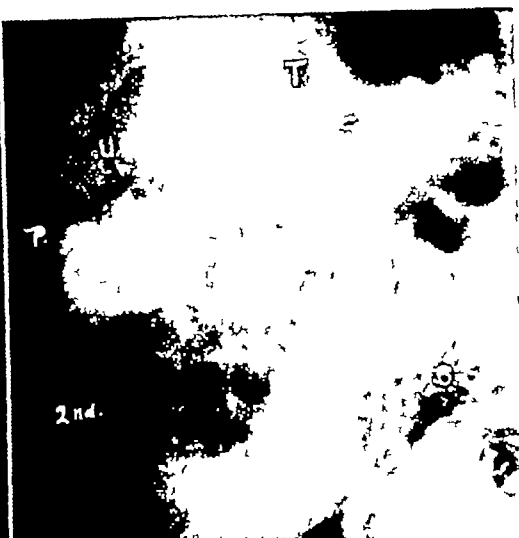


Fig 2 A case of duodenal ulcer S, Stomach with regurgitated barium T, Tube in stomach P, Duodenal cap U, Ulcer niche 2nd, Second portion of duodenum B, Balloon in fourth portion

too sudden increase of pressure in the duodenum shall not be caused. I feel that an amount of air just sufficient to distend the balloon to a diameter of 2.5 cm as determined before intubation, should be injected at first, then the barium mixture allowed to run in slowly if a small amount of the barium escapes beyond the balloon more air can be introduced slowly until one sees the opaque substance fill the proximal duodenum. Fluoroscopic observations are made continuously while the cap and the rest of the duodenum above the obstruction are being filled, films being exposed at any desired times. The tube is withdrawn after deflation of the balloon at the end of the examination.

Material—Out-patients of the Gastrointestinal Section and ward patients of the Medical Clinic of this hospital were available for this work. All of those subjected to the special investigation had previously undergone a gastro-intestinal roentgen examination by the regular method of the Radiologic Department of the hospital, thus making it possible to compare the results of the two methods of study.

Forty-three intubations were attempted on 10 patients. The first 18 patients were

selected irrespective of their disease or previous roentgenologic results, the others were chosen because of the inconclusiveness of their original roentgenologic examination and the help that it was hoped might be secured by such a special study. Ten of the cases must be eliminated from consideration in the results, six (15 per cent of the total number) because of failure to get the balloon into the third portion of the duodenum, and four because of improper technic after intubation. Of the remaining 30 cases, 12 proved to be negative for any duodenal disease, while 18 showed pathologic lesions, seven, duodenal ulcer (one with adhesions), six, duodenal adhesions only, two, dilated ampulla of Vater, one, open communication between duodenum and common bile duct, one, an enlarged head of the pancreas, and one, mesenteric occlusion.

Results in Normal Cases—The 12 patients in this group were considered to have no duodenal pathologic lesion on the basis of clinical study and routine roentgen examination. In them, retrograde filling of the duodenum with an opaque substance caused that organ to assume under the fluoroscope an appearance quite different

from that observed following the usual oral administration. The shape of the first portion corresponded more closely to that of a bulb than it did to that of a cap. It had the shape of a pear, with its larger end or base toward the pylorus of the stomach, instead of that of a miter-like cap setting on top of the gastric antrum. The shadow of the bulb was of a constant uniform density and seemed almost to be an extension of the antrum except for the sharp incisure of the pyloric muscle. The sides of this pear-shaped bulb were symmetrical and the clear-cut contour of the organ showed no irregularities, projections, or indentures. The size of the bulb varied with the amount of distention brought about in the individual case, and the measurements were not highly significant, it was possible, however, to estimate the point at which there was complete filling without appreciable stretching of the walls, and in this way a fair idea of the size was obtainable. Measurements were made on films taken in a uniform way during the examination. The width was determined at the widest part or base, and the length, from the pyloric ring to the beginning of the second portion of the duodenum (recognized by the point of maximal narrowing). The average width was 4.2 cm., and the average length was 5 centimeters. The second part of the duodenum extended posteriorly and downward from the end of the bulb to the inferior genu. It appeared as a cylinder of more or less uniform diameter throughout, the average width being 3.4 centimeters. The contour of this portion was unlike that of the bulb, showing multiple indentures on either wall of fairly uniform shape that were caused by the modified valvulae conniventes. There were no out-pouchings or extensions from the line of the walls, and the shadow was of uniform density. When this part was emptied of barium the arrangement of the mucosal pattern was seen as a lace-like network of thin pale strands.

No definite degree of irritability was observed in any part of the duodenum in

spite of the presence of the tube. At the first introduction of the barium mixture a small immobile deposit was noted, which then gradually regurgitated toward the pylorus. The bulb was usually retentive to the minimal or maximal amount of barium reaching it. After deflation of the balloon the whole duodenum emptied quickly, with the exception of the small amount which remained between the folds of mucosa in the second part.

Results in Pathologic Cases—Evidence of pathology in the duodenum was revealed by some change in the shape, size, contour, or density of the roentgenologic shadow. The most conclusive evidence of an ulcer was the demonstration of a niche, caused by the opaque substance filling the crater of the ulcer and so giving in profile a projection from the wall of the bulb. When the right and left aspects of the cap were thrown into maximal relief by manipulation of the patient, the niche appeared as a small teat-like projection with a depressed area on either side. This appearing on one side only made the bulb asymmetrical (Fig. 2). Due to forced filling the whole ulcer crater was visualized and its direct connection with the bulb shadow was usually demonstrable; this is often not possible by the routine examination. When the opaque substance enters the duodenal bulb slowly from the stomach and no obstruction exists, the examiner is often at a loss to know whether he should attribute such irregularity to an incompletely filled cap or to organic disease. Furthermore, when a spot of barium lies apart from the larger mass in the unfilled cap, and a connection with it cannot be demonstrated, the examiner often cannot determine whether or not it represents an ulcer. With the intubation technic these difficulties did not arise, because, as before stated, the bulb presented itself as a solid shadow of definite outline and shape, and the filled ulcer crater showed a direct connection with the duodenal lumen. Because of this, one should be able by repeated examinations to determine if an ulcer is healing by observing a change in

the size of the niche from time to time. An incisura of the duodenal wall opposite the ulcer niche, such as is commonly observed in gastric ulcer, was seen fluoroscopically in three cases. This was undoubtedly due to spasm, since under increased filling pressure it was seen to lessen in depth and at times to disappear. By routine methods such a spasm may remain constant and thus be confused with an extrinsic disease or an actual organic constriction of the wall. It was not always possible to visualize the ulcer crater in relief, especially when it was present on the posterior wall, in such instances, however, it was demonstrable with the bulb only partially filled, or after it had been emptied, as a small fleck of opaque substance on the mucosal surface of the wall. From this fleck were seen several small, short, radiating strands caused by distortion of the mucosa about the edge of the ulcer crater. This appearance was analogous to that seen when using the "small meal technic". Besides the localized spasm, as characterized by an incisura, there was noted in the ulcer cases a general contraction of the whole duodenal bulb, which caused it to be somewhat smaller than normal. In the ulcer cases, the average width was 3.7 cm and the average length 5.1 centimeters. In addition, some evidence of irritability in the ulcer cases was observed, and this sometimes caused a large amount of regurgitation of the barium mixture into the stomach before the cap became completely filled.

The presence of peri-bulbar adhesions often produces an irregularity which by the usual method of examination may be taken for a deformity due to an ulcer. This was not the case with our procedure, because the well filled niche was definitely characteristic and the irregularities of contour caused by adhesions in no way resembled it. In the presence of adhesions the bulbar wall had no wavy or saw-tooth appearance. The irregular projections from the otherwise smooth contour were sharply pointed as though held out by in-

visible threads. These areas were usually multiple, and no spasm or irritability was demonstrated in the cap. The ability to differentiate between adhesions and ulcer of the bulb by this technic commends its use in all doubtful cases.

In the second part of the duodenum, adhesions revealed themselves by a displacement of the intestinal wall in localized areas. The shadow appeared as an angular projection from its contour, either single or multiple, with some shift of the whole image in that area in the same direction. The width of the organ was increased to 4.5 cm in one case and to 4 cm in another case, with adhesions of the pulling type. In another case in which the adhesions were of a constricting nature and affected the whole circumference of the intestine, the lumen was narrowed to 2 cm in diameter. In cases showing evidences of adhesions about the second part, no enlargement of the parts of the duodenum proximal to them was observed.

The size and shape of the duodenal cap were changed in four cases, without any irregularity in outline or contour being found. One of them showed a small cap 3.5 cm wide and 4.5 cm long, associated with a general spastic condition of the stomach and colon as shown by a previous routine study. Three cases showed an enlarged bulb, one being due to an occlusion at the site of the mesenteric vessels, and the other two, to stasis of undetermined origin. In the first case with a large bulb the latter was globular in shape and almost as wide as it was long, the width being 5 cm and the length 6.5 centimeters. The second part of the duodenum in this case was also enlarged to a diameter of 5.5 cm just proximal to the constricted area, which was only 1.7 cm wide. Exaggerated peristalsis and reverse peristalsis were also noted in the dilated part. This was typical of an obstruction as the whole proximal duodenum was enlarged above the constriction and the barium remained in the dilated part longer than usual after deflation of the balloon. In the two other cases of stasis

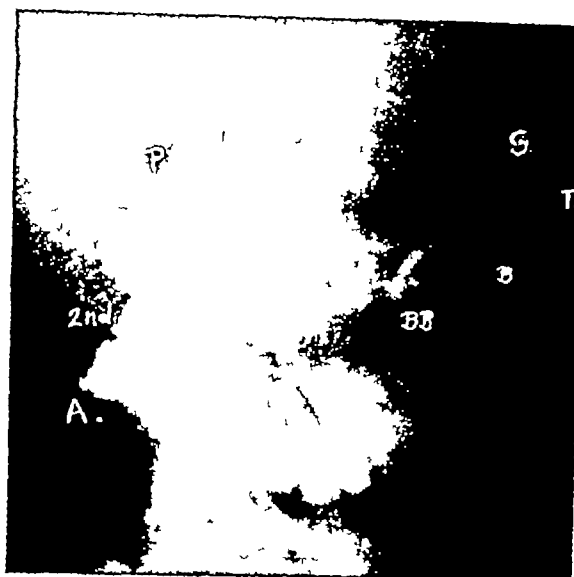


Fig 3 A case of duodenal adhesions S Stomach T, Tube in stomach 2nd, Second portion of duodenum P, Duodenal cap B Dilated balloon BB Bucket inside of balloon A, Adhesions



Fig 4 A case of cholecystoduodenal fistula S Stomach with regurgitated barium P Duodenal cap GB, Barium in gall bladder T Tube in second portion of duodenum HD Hepatic duct

the bulb measured 4.5 cm by 6.5 cm, and 5.5 cm by 4.5 cm, respectively. They also were globular in shape and perfectly smooth in outline. The second part was 4.5 cm wide in each instance. No evidence of undue retention of barium in the dilated parts and no excess peristalsis occurred.

Irritability of the duodenum was observed chiefly in the descending part. With the first introduction of the barium mixture in several cases a violent churning and reverse peristalsis were so marked that none of the opaque substance was retained in this portion of the duodenum throughout the examination and scarcely any stopped in the cap but was regurgitated back into the stomach. Increased forward peristalsis, revealed by a continuous effort of the intestine to propel the inflated balloon distally, also occurred. Examination by the usual barium meal technique rarely demonstrates such a degree of irritability because the meal passes out of the duodenal bulb in finger-like masses which are hurried toward the jejunum more or less in spurts, the rapidity of its

movement not always being recognizable. Under such circumstances reverse peristalsis does not occur unless there be distal obstruction, with marked stasis.

The common bile duct and right and left hepatic ducts were visualized in one case, due to a fistula between the common bile duct or gall bladder and the duodenum (Fig 4). The bulb was globular in shape and slightly wider than long, the barium shadow extended into a small contracted gall bladder to its right and into the common bile duct and both hepatic ducts. This method made it possible to force the barium mixture into these channels. It was not possible in any other instance to force barium into the common bile duct—taken to be evidence that dilation of the duodenum alone is not sufficient to bring about an open communication between the duodenum and the common duct.

Two cases showed a smooth-walled sac budding from the mesial surface of the middle of the descending portion of the duodenum. These sacs were about one centimeter in diameter and retained barium after the remainder of the gut was

empty On account of their location they were thought to be due to dilated ampullæ of Vater In one case there was definite narrowing of the whole of the descending portion of the duodenum to a width of one centimeter Operation showed that this was due to the extrinsic pressure of a dilated gall bladder on one side and of an enlarged pancreas on the other, evidenced by a greatly enlarged duodenal loop

CONCLUSIONS

1 An improved technic is described for the roentgenologic study of the duodenum, utilizing a newly developed double-lumened tube by means of which the distal portion of the organ is obturated and the proximal portions are filled with an opaque substance in retrograde fashion

2 The chief advantages of this procedure lie in the opportunity to fill completely the first and second portions of the duodenum, to distend them moderately, and to avoid the gastric shadow which with the usual opaque meal may obscure the duodenal image in cases with the hypertonic type of stomach

3 As a result of experience with this special method of examination in 30 clinical cases, 12 of which were normal and 18 pathologic, it has been demonstrated that sometimes certain lesions, not clearly recognizable by the ordinary roentgenologic methods, may be identified

4 In this series of cases the technic here described has served to confirm the diagnosis of a normal duodenum in twelve, of duodenal ulcer in seven, to differentiate adhesions from ulcer in four, to rule out both ulcer and adhesions in three, to demonstrate a cholecystoduodenal fistula in one, a dilated ampulla of Vater in three, duodenal occlusion or stasis in three, and

an enlarged head of the pancreas in one case

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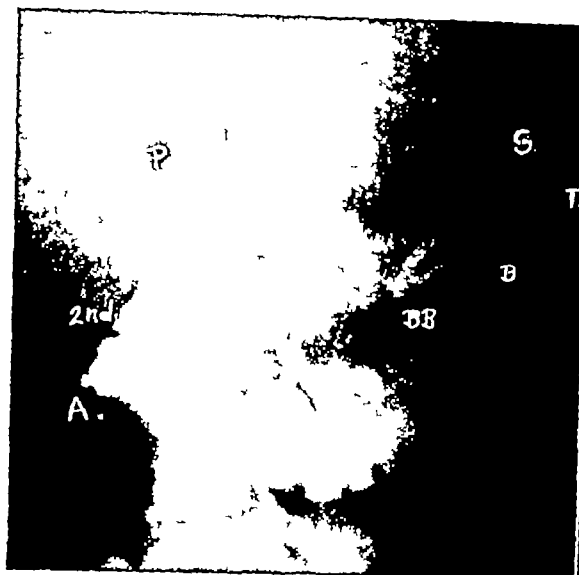


Fig 3 A case of duodenal adhesions S Stomach
T, Tube in stomach 2nd Second portion of duodenum
P, Duodenal cap B Dilated balloon BB Bucket
inside of balloon A Adhesions



Fig 4 A case of cholecystoduodenal fistula
S Stomach with regurgitated barium P Duo-
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Two cases showed a smooth-walled sac budding from the mesial surface of the middle of the descending portion of the duodenum. These sacs were about one centimeter in diameter and retained barium after the remainder of the gut was

produce changes simulating chronic sinusitis in the human. Dr. Larsell and his assistant, Mr. L. M. Bain, were kind

time the cats were divided into three groups for study.

Group 1 consisted of three cats which

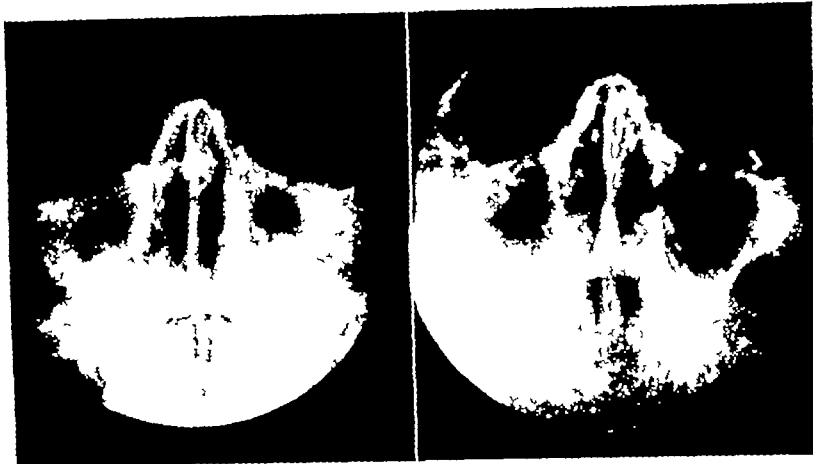


Fig 1-A Case 1 Radiograph of the antra at the time of the first treatment. Symptoms date back four years.

Fig 1-B Case 1 One year following first treatment. Symptomatically, much improved. Illustrative of Group 1.

enough to give us their help and in this way we were able to duplicate their technique and to elaborate upon it to suit the needs of this particular study. As to how closely we could approach tissue changes comparable to those in chronic sinusitis in humans, none of us knew. (Fenton and Larsell's work had been done entirely upon acute changes.) It was not known how long it might be possible to keep a cat infected, and this, with the other unknown factors, caused some doubt as to how complete our study might be, although we did feel that we could at least find out what, if any, harmful changes might result. Twelve cats were selected and the right frontal sinus in each was punctured and infected with a virulent hemolytic streptococcal culture taken from a mastoid (July, 1932). All of the cats showed definite evidence of infection within a few days and two of them died as the result of it. As before stated, it was not known how long it would be possible to maintain the infection, so we arbitrarily selected three weeks as the time that should elapse before treatment was instituted. Accordingly at the end of this

were irradiated over both frontal sinuses using the dose that we consider standard for the human (800 r).

Group 2 also consisted of three cats which received twice the standard dose (1,600 r) over both frontals, the increased dose being given to determine what harmful results might occur from excessive irradiation.

Group 3 consisted of the four remaining cats which had been infected but were not irradiated. These cats were used as controls.

One cat from each group was killed at the end of one week, a second at the end of three weeks, and a third at the end of three months, following irradiation. The sinuses were exposed for gross inspection and the anterior portions of the skulls were then placed in Zenker-formal solution. After the membranes had hardened, they were rolled in wheat shock manner, blocked, sectioned, and stained. It then appeared advisable to determine the earlier changes that might take place in the first few days following irradiation. Accordingly another series of cats was prepared as before and killed 24, 48, and 72 hours

ROENTGEN THERAPY IN CHRONIC SINUSITIS¹

A FURTHER REPORT

By FRANK E BUTLER, M D , and IVAN M WOOLLEY, M D , *Portland, Oregon*

From the Department of Radiology, University of Oregon Medical School

IN 1930 our first roentgen treatment for chronic nasal accessory sinusitis was given, and the results obtained in this and 100 subsequent cases were presented before the Alumni Association of the University of Oregon Medical School in 1932 (1). At that time we were able to report 31 per cent symptom-free, 50 per cent definitely improved, and 19 per cent unchanged. These were all chronic cases which had been referred by their physicians as cases that were considered unresponsive to other therapy and therefore operative.

The rationale for such treatment was based upon the excellent results of x-ray therapy upon inflammatory and hypertrophic pathology elsewhere in the body, which have been known for years to respond satisfactorily.

The publication of our first report aroused considerable interest and also some criticism. Fears were expressed as to the possibility of damage to the skin, blood vessels, nerves, and even to the brain itself. These fears could be readily put at rest by referring to past experience, it having been repeatedly proved that roentgen therapy in the hands of a physician skilled in its use need cause no fear of damage. Safety rests with the skill of the operator in irradiation therapy just as it does in surgery or any of the other types of therapeutics.

It was also suggested that the sense of smell might be impaired or destroyed from the effects of irradiation. When one considers the fact that nerve tissue is the most resistant of all body structures to the effects of the x-ray (2 and 3), he need have

little to worry about on that score. None of our patients has mentioned any impairment in this regard, and one, who, by the way, has had by far the heaviest irradiation of any of our series, recovered the sense of smell which had been absent several years.

It was thought by some that an extreme fibrosis might result which would make it difficult, if not impossible, to properly extirpate the mucous membrane if such should become necessary in the event that the roentgen application failed. This objection has also been proved groundless, as will be pointed out later in this paper.

We were somewhat apprehensive as to the effect upon tooth buds in children and have exercised care in trying to shield them. Thus far there has been no evidence of any difficulty on this score, and in chronic sinusitis of children when radical surgery is contra-indicated, this form of treatment is particularly effective.

As to the action upon the cilia and cellular structures of the sinus membranes following irradiation, we could not definitely say. Logically, it could be expected that the lymphoid tissue and lymphoid cells would be broken down, with some later fibrosis, which would tend to sclerose the tissues and make it difficult for the infection to survive or for reinfection to occur. The shrinking of the membrane should then permit freer drainage of the cells.

Dr Ralph Fenton, of the Department of Otolaryngology, and Dr Olof Larsell, of the Department of Anatomy of the University of Oregon Medical School, had just completed some experimental work on acute sinusitis in cats, and they suggested that it might be possible to elaborate upon their technic in such a way as to

¹ Read before the Section on Radiology at the Eighty-fifth Annual Session of the American Medical Association, Cleveland Ohio June 13 1934

Group 3 Atrophic types of membrane
 Group 4 Chronic sinusitis with densely fibrotic membranes

but all involved areas are treated upon the same day The central ray is so directed as to produce a cross-firing of the



Fig 3-A Case 2 Radiograph showing the antra at time of treatment
 Symptoms date back two years
 Fig 3-B Case 2 Six weeks following irradiation Patient remains symptom free Illustrative of Group 1

Group 5 Post-operative cases following unsuccessful radical surgery

These are all cases of long-standing, some of them dating back as long as twenty years, and have been referred to us as patients who were definitely not allergic and who had failed to respond to the usual types of treatment During the course of this series we have developed a rather definite technic, and our results, tabulated upon 450 cases in which it has been possible to obtain follow-up data, show 36 per cent that are entirely relieved up to the present time, 55 per cent definitely improved, and 9 per cent that have been only slightly improved or not helped at all

In Group 1, consisting of chronic cases in which the radiograph shows a definitely thickened membrane with only a small air-containing cavity, we have had our best results The technic used here consists of 120 K V P, 5 ma, 11 inch distance, 4 mm of aluminum filter, for ten minutes through a port one and one-quarter inch in diameter These factors as applied by our equipment give a dose of 800 roentgens as measured with the Victoreen instrument with back-scattering This dose is applied over each group of cells separately,

posterior ethmoid and sphenoid cells The eyes and the nose are carefully protected at all times

The following case reports are illustrative of this group

CASE REPORTS

Case 1 E A F, male, aged 45 years, was referred by his rhinologist for treatment His symptoms dated back four years, during which time he had failed to respond to routine therapy Radiographs taken on this date (March 31, 1931) showed bilateral thickening of the membranes in the antra, with hazing of the ethmoids also The antra were irradiated and the patient failed to return until one year later He reported decided improvement but still had some discharge The membranes, although reduced, were still definitely thickened The ethmoid fields were still hazy A second treatment was given over the antra and this time the ethmoid areas were also included (April 2, 1932) A check-up six weeks later showed a definite improvement and no further treatment was given Three months later (Aug 17, 1932) he returned for treatment of a carbuncle and reported that he had had

following irradiation. The membranes were processed as above mentioned.²

Following the microscopic study of the

"In the animals given the double dose there was in one instance some indication of abnormal activity of the epithelium."

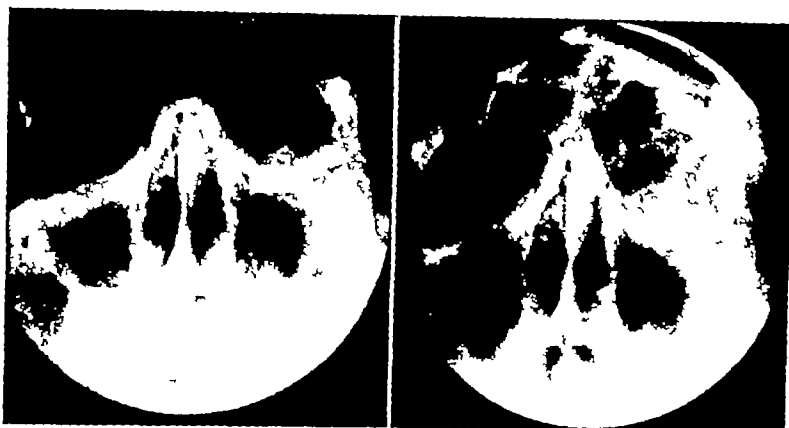


Fig 2-A Case 1 Appearance of the antra six weeks after the second treatment

Fig 2-B Case 1 Radiograph made three months after the second treatment. Patient is symptom free. Illustrative of Group 1

slides prepared in this experiment, Dr Larsell summarized the findings as follows:

"The effect of the x-ray treatment appears to be due primarily to an early destruction of the lymphocytes in the infected membranes. About 48 to 72 hours after treatment of membranes which had been infected for several weeks, there appears to be an increase in the number of macrophages. These are believed to come in response to substances released by the breaking down of the lymphocytes. These macrophages are seen to be laden with cellular debris and blood pigments. It is possible that they also engulf bacteria.

"The membrane becomes gradually reduced in thickness but retains numerous plasma cells, polymorphs, and some histocytes. After a week or more some fibrosis appears. Several weeks after irradiation, nodule-like masses of lymphocytes may be seen in some of the membranes, indicating a return of lymphocyte formation.

"There is no evidence of injury to the cilia, epithelium, or cellular elements other than the lymphocytes as the result of x-ray dosage. The fibrosis is considered a result of the inflammatory process, and the increased number of histocytes immediately following the infection.

² For the technic used throughout this work we refer the reader to Fenton and Larsell's article (4).

While this work has given us valuable information leading to a better understanding of how these tissues react to irradiation we felt that the results were not exactly comparable to what might be expected clinically, as we were forced to give heavy irradiation in the presence of acute and in some cases fulminating infection, which, of course, we would not do in treating a human. By this we do not wish to infer that roentgen therapy is contraindicated in acute sinusitis, but in such cases the dose must be kept considerably lower.

We realize that the experimental work here reported does not begin to tell the entire story and we have no doubt that with the knowledge gained in this series, further studies along this line should give more complete information. Having in a measure established the background of the rationale of roentgen therapy in this field, a report of the clinical results obtained by this method should prove to be of interest.

Our clinical experience is based upon a series of 700 cases which may be roughly divided into five groups, as follows:

Group 1 Chronic infection with hypertrophic membranes

Group 2 Cases having polypi or cysts

repeated fractional doses in which we have given one-sixth of the standard 800 r dose every week for a period of six weeks

now subside more or less spontaneously in a few days' time, although he still has some nasal discharge at times. It is possible



Fig 5-A Case 4 Radiograph at the time of treatment showing evidence of a pansinusitis. History of nasal discharge, sinus bronchitis, and recurrent head colds dates back many years.

Fig 5-B Case 4 Check up film made ten months following irradiation. Patient reports marked clinical improvement. Illustrative of Group 4.

In Group 4, in which we encounter rather densely fibrotic membranes, we have found rather variable results. Some of these cases which appeared at the outset to present but little hope of result have returned free of symptoms, and radiographic check-up has shown an antrum of normal appearance. Others show varying degrees of improvement, and still others show no changes at all.

Case 4 This was a physician, aged 45 years, who stated that for a period of years he had never been free from nasal discharge of varying degrees of severity, and that every fresh cold precipitated an acute sinus flare-up, requiring loss of time of from several days to a week. Radiographs showed a chronic pansinusitis. He was irradiated on July 22, 1931, and obtained marked relief, but still had occasional discharge. He did not return until April, 1932, at which time the radiograph showed no appreciable change. The ethmoids were treated on this date. A recent conversation with him brought out the statement that he has had no acute flare-ups since the first treatment, that nose colds

that further treatment might produce additional benefit in this case.

In Group 5 we have also found some variation. For the most part these patients present sinuses that are practically occluded with dense fibrotic scar tissue and very little, if any, change can be detected following irradiation, although the patient frequently states that he is clinically improved. Except for the variations above noted, our technic is fairly standard. As before mentioned, the full dose is given at one visit, and the patient is asked to return in two months for a recheck. The usual reaction is that of stimulation at first, productive of increased discharge, which persists for from several days to a week, and then gradually subsides. A few cases have had an increased swelling of the membrane, producing occlusion of the ostium, necessitating puncture and washing. This, however, has been a rather rare complication. A few cases have reacted in an opposite manner in that the discharge has completely ceased within a few hours.

In those cases suffering from secondary

no further evidence of sinus involvement
A film made on that date showed the
sinuses to be clear

Case 3 V C, female, aged 8 years, was
referred by a pediatrician, because of
chronic sinus involvement with a severe

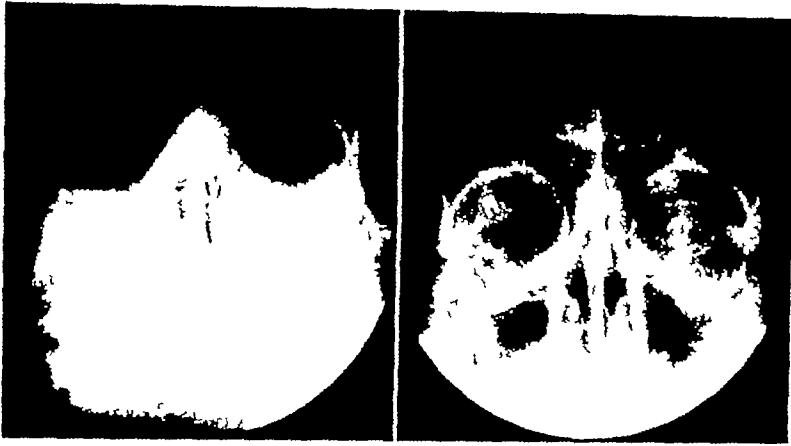


Fig 4-A Case 3 The patient was a child eight years of age History of
discharge and severe sinus bronchitis dates back six months

Fig 4-B Case 3 Radiograph made seven months after irradiation when
patient returned with whooping cough Radiograph shows the antra clear except
for a polyp or cyst in the floor of the right maxillary Illustrative of Group Two

Case 2 C B, female, aged 40 years,
was referred by her internist with a com-
plaint of chronic nasal discharge, headache,
and general malaise Sinus involvement
had been known for two years, but there
had been no recent treatment Irradia-
tion was given on December 20, and the
patient noted an increased discharge for
six days, whereupon it gradually subsided
and finally ceased entirely approximately
ten days following treatment A recheck
on February 2 showed both antra to be
clear and the patient reported complete
recovery as far as her previous symptoms
were concerned More recent inquiry has
elicited the information that she is still
symptom-free

In Group 2, in cases in which polypi or
dental cysts are present, we have had no
appreciable results except in a few
cases that are still under observation, in
these, the polypi have been excised and
irradiation has been given in an attempt to
abort a further development Thus far
the work appears to be very encouraging
The following case may be of some interest
in this regard

sinus bronchitis At the time of the
treatment (Sept 7, 1933) both sinuses
were opaque, and radiographically sug-
gested an acute involvement although the
history of the discharge and bronchitis
dated back six months She failed to
report back to the pediatrician or to our
office at the stipulated two month's inter-
val On April 19, she was returned by her
mother, who complained that she was no
better than at the time of her first visit
Questioning developed the fact that she
had shown marked improvement within a
week after treatment and that her dis-
charge and bronchitis had subsided en-
tirely within a month She had developed
another severe cough ten days before this
last visit, which followed an acute rhinitis
Radiographic check-up showed both antra
to be entirely clear except for a small
cyst in the inferior angle of the right an-
trum She was referred back to her
physician, who diagnosed whooping cough,
and there has been no developing evidence
of sinus involvement

In Group 3 the atrophic type of sinusitis
has shown response, in some cases, to

5 Complete co-operation of the referring physician and roentgenologist, with proper selection of cases, should result in a higher percentage of cures

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DISCUSSION

DR A U DESJARDINS (Rochester, Minn) This communication by Dr Butler and Dr Woolley is most interesting because it tends to show that inflammation of the paranasal sinuses, like inflammatory processes of different kinds elsewhere in the body, is distinctly amenable to radiotherapy. One point especially interests me, and this is the description by Dr Larsell of the pathologic changes which he found in sections of infected sinus tissue treated with roentgen rays. The fact that the primary effect of the rays was an early destruction of lymphocytes infiltrating the infected membranes agrees with many other observations, experimental and clinical, which have been made in the past, and all of which tend to show that the first and main effect of irradiation on inflammatory processes is to destroy infiltrating lymphocytes. This is undoubtedly and necessarily accompanied by liberation of anti-bodies, ferments and other protective substances which these infiltrating lymphocytes may have contained, and is followed by an increase in phagocytosis. The description of these changes given by Dr Larsell absolutely confirms this sequence of events.

Another point which interests me considerably is the doses of roentgen rays which Dr Butler and Dr Woolley have used in treating paranasal sinusitis in

human beings. I take it for granted that the dose of 800 roentgens, mentioned in the paper, means 800 roentgens measured on the skin (that is to say, with scattering). This would correspond to a dose of approximately 500 roentgens measured in air. If this assumption is correct and if we take into account the fact that paranasal sinusitis is usually a chronic inflammatory process, although it is characterized by occasional flare-ups, such a dose corresponds with the doses known to be effective in many other chronic inflammatory processes.

I am also impressed by the fact that one or, at most, two irradiations have been found sufficient to rid patients of this distressing condition. A minor point which might be mentioned is the increase in secretion which has been described as following irradiation and which is replaced later by diminished secretion. No doubt, the increase in secretion is due to the effect of the rays on the mucus-producing epithelial cells. It is well known that epithelial cells having the property of secreting mucus, undergo, after irradiation, mucoid degeneration, with increased secretion—it may continue for a number of days and be followed by reduction in the amount of secretion. In every respect, therefore, the experiences of Dr Butler and Dr Woolley, both on experimental animals and on human beings, agree with what is known to occur in many other forms of inflammation. Their report should lead to a revision of our ideas concerning the treatment of sinusitis and, as specialists make use of it, should prove a boon to many sufferers.

I think if the dose is somewhere between three-fourths and four-fifths of an erythema dose, I should be inclined to use more filter and more voltage. In dealing with inflammation of the sphenoid sinuses, which are fairly deep, too small a dose may not be so effective.

DR RALPH A FENTON (Portland, Oregon) Otolaryngologists are much interested in Dr Woolley's fine piece of re-

symptoms definitely ascribed to sinus infection, there has been a very gratifying response. Headaches, bronchitis, neuritis, and other minor complaints have cleared up, even in cases in which there was not a complete resolution of sinus pathology at the time the recheck was made. In the large majority of cases one treatment has been sufficient to gain satisfactory results, although many have required a second exposure in from two months to a year's time. One post-operative patient has received five treatments scattered over a period of three years and during the past year has remained quite comfortable. It has been our good fortune to escape sequelæ of a serious nature throughout this series, and, with the exception of two or three patients, none has lost any time from his work as the result of the treatment.

Our records show seven cases that have come to surgery following failure to secure relief from roentgen therapy. Fenton reports two cases of chronic maxillary sinusitis who received irradiation over one antrum, one month prior to bilateral extirpation in an effort to determine the comparative changes in the membranes. Of this total of seven known cases we have received pathologic reports on six, and a careful comparison of the slides shows but little change from the usual findings in similar, non-irradiated membranes. Here again was noted a return of lymphocytes in some of the membranes removed several months following irradiation, as was seen in some of our cat membranes. This brings up the question as to whether or not we might have succeeded had we given further irradiation at intervals over a longer period of time, thus providing further breaking down of lymphocytes and restimulation of histocytic invasion. Two post-operative membranes showed a considerable number of small cysts scattered throughout, and it appears that further irradiation of this type would give no additional benefit. In none of these membranes were there any evidences of damage to the normal cell structures, and the sur-

geons reported that there was no difficulty encountered in the removal of the tissues. This was also found to be true in the irradiated cat membranes.

Regarding our selections of dosage, we have found far better results in cases given single, full doses than in those in which fractional dosage was employed. We have further learned the necessity of treating all the infected areas at one time, thereby eliminating as much as possible the tendency toward reinfection from untreated foci. We have occasionally seen a slight erythema develop over the site of irradiation, but this has subsided without further difficulty.

In conclusion, we wish to place especial emphasis upon the fact that while we have stated rather positively that no harm has resulted from roentgen application in this series, we do not wish to leave the impression that the procedure is without danger. Roentgen therapy should not be attempted by any physician who is not well experienced in that field. Skin tolerance and proper filtration must at all times be kept in mind, and repeat treatment must not be given until a safe interval has elapsed. Serious and irreparable damage may result through careless or unskilled application of the roentgen ray. Of equal importance is the matter of diagnosis, and we should like to particularly stress the necessity of complete co-operation between the referring physician and the roentgenologist, in order to avoid treatment of cases in which roentgen therapy is definitely contra-indicated.

SUMMARY

1. Roentgen therapy has a definite place in the treatment of chronic paranasal sinusitis in properly selected cases.

2. The rationale for such therapy has been established.

3. There is no damage to normal structures, when properly applied.

4. Failure of roentgen therapy in no way interferes with subsequent surgery, should the latter become necessary.

recommended, may get into the greedy hands of irresponsible and untrained quacks and irregular practitioners

DR G A ROBINSON (New York) I wish to congratulate the Doctor on giving us an added method of treatment in chronic sinusitis. There is a tendency (and I think rightly so) to do less radical surgery in nasal sinus disease.

We have used radium in a great many cases of polypoid ethmoiditis, with encouraging results. The method was started several years ago by Dr Sluder and Dr Lyons.

In polypoid ethmoiditis, Dr Woolley reports his results as not so good as in the thickened membrane of the antrum and frontal sinus. One can deliver with the radium capsule as great a dose as one cares to give. It is difficult to apply a dose from a radium tube into a maxillary antrum, and we cannot use the time-consuming method of treating the sinuses externally with radium packs. We have tried it in a few cases and found clinical improvement.

DR JOHN D OSMOND (Cleveland, Ohio) I wish to congratulate Dr Butler and Dr Woolley on this presentation. It is a step forward.

I wish to give one caution in regard to the treatment of any case that is fairly acute and has retained pus. I began this treatment before 1922 and reported it at the 1922 Los Angeles meeting of the American Roentgen Ray Society. It was a small series, but I spoke a word of caution at that time—when the antrum or other infected sinus is not properly drained, one should not treat it. It must be washed out first. At that time I did not think that chronic sinusitis would do well, but I have since changed my mind. We have treated about 250 cases with comparable results.

DR G E PFAHLER (Philadelphia) I, first of all, want to congratulate Dr Woolley and his colleagues on this presen-

tation. It was one of the most important presentations we have had because the field is so very large. I also think that we are fortunate in having Dr Fenton and Dr Desjardins open this discussion.

I have not treated many cases of paranasal sinusitis. Most of the cases I have treated have been in physicians, one of whom was myself. Having suffered from paranasal sinusitis for approximately fifty years, and being in better condition now than I have been at any time during that period, I can speak rather feelingly.

I have not used the large doses. We have used high voltage x-rays, 0.5 mm of copper filtration, and 25 per cent surface dose, giving the treatment at one time through the sinuses anteriorly, protecting the eyes, eyebrows, and lips. Then perhaps a week later, we treat laterally on one side and then on the other side. It does seem to me, theoretically, that that line of treatment ought to give us better results than all of this treatment in one dose.

DR IVAN M WOOLLEY (closing) I wish to thank the gentlemen who discussed this paper, especially Dr Desjardins and Dr Fenton, the latter of whom left his own Section to come here for that purpose.

We have not at any time held that this type of treatment was a cure-all for all types of sinus conditions. We believe it has a definite place in the field of sinus therapy, that with further experience it will definitely find its level, and that by this means we will be able to offer relief to many patients who at the present time are not being relieved.

As far as the caution about treating acute cases is concerned, it is a point well taken. We do not treat acute cases in their fulminating stage but wait until they are in the sub-acute stage.

The matter of diagnosis is extremely important and it is our hope, as the work develops, that co-operation between the otolaryngologist and the radiologist may be productive of a greater percentage of cures in these particular types of cases.

search, which arose from our criticism of clinical results reported by Dr Butler and Dr Woolley two years ago before the Oregon Academy of Ophthalmology and Otolaryngology. We asked then what happened to these inflamed mucosal surfaces after irradiation, they told us of certain percentages, gratifyingly high, of clinical betterment, and of improved radiographic evidence. They were, however, unable to tell us what took place in the tissues, until microscopic examination of these cat membranes, infected after our technic.

Prof Larsell and I have elsewhere reported on the examination of chronic cat membranes, and of certain human membranes, one month and six months after irradiation. It need not be emphasized to this Section that therapeutic use of the roentgen ray does not sterilize sinus membranes, they become swollen, often to such an extent (pointed out long ago in Vienna) as to cause annoying pressure symptoms from retained secretion. Then the killed lymphocytes are carried away by an inrush of phagocytic connective cells, with resultant local accumulation of immune substances, increased blood supply, and eventual fibrotic changes, without damage to epithelial structures.

This is all very well, if the membrane treated contains plenty of round cells to kill. What of the highly edematous membrane full of plasma cells, or the membrane already thick and fibrous? Either of these may contain numerous milium to pea-sized abscesses or cysts, which will remain untouched by the irradiation. Either condition will look dark in the radiograph. So also will a syphilitic thickening of the mucosa, so will a beginning adenocarcinoma.

A word of warning must be sounded lest roentgenologists proceed to use this method indiscriminately, on the recommendation of general practitioners and pediatricists, or on their own. Every case, as Woolley states, must be checked before and after by a competent otolaryngologist, otherwise much trouble may ensue.

Let me say also that this treatment is no guarantee against recurrences. When foul dental roots are responsible for antral discharge, when allergic sensitiveness continues to block ethmoidal drainage and favor reinfection, when fibrotic membranes contain virulent streptococci in multiple abscesses surrounded by networks of new capillaries, we have repeatedly observed, clinically and under the microscope, that patients who have experienced temporary relief from roentgen-ray treatment of the sinuses will have recurrences that require both medical and surgical measures for permanent cure. Properly performed radical surgery is followed by regrowth of normal ciliated mucous membrane. One wonders whether, after therapeutic irradiation, the thickened and fibrotic membrane will in later years be as safe and as useful as the new, thin, and healthy membrane found after surgery is adequately done.

We have nothing but praise for the modesty of Dr Woolley's conclusions, for his industry and his patience, but we would like further reports after the lapse of several years. Reports from Hamburg and Vienna were not so encouraging, when reported in Germany in 1927. Our laboratories welcome further research along this line, and we would suggest that animals kept infected for several months would afford a pretty good criterion of the eventual measure of repair in similarly chronic human cases. After all, the simple round-cell infiltrative type of sinusitis is that which yields most readily to ordinary measures. Here, Dr Butler and Dr Woolley have had their best results, however, they still consider this an experimental procedure.

There is real danger, however, that cytologic examination of sinus washings, lipiodol injection, and careful rhinologic study will be omitted by some radiologists who will attempt this method on any one who says he has "sinus trouble" or shows a slightly darkened sinus plate. This Section should look well to the danger that this valuable method, if indiscriminately

recommended, may get into the greedy hands of irresponsible and untrained quacks and irregular practitioners

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IRRADIATION OF RADIOSENSITIVE TUMORS¹

By MAX KAHN, M D , *Baltimore, Md*

IN a study of radiosensitive tumors it may be of interest to review one or two cases living for a number of years that had malignant tumors and that were treated with the roentgen ray. Patients are from time to time referred for roentgen therapy who either have an inoperable tumor, or a large tumor which is inaccessible to operation, or for palliative treatment. It is gratifying to find that the results in some of these hopeless cases are excellent, the patient remaining clinically well for years.

Therapeutic roentgen rays have been used for some years as a diagnostic agent in identifying the pathology of certain varieties of tumors. Desjardins (1), who has rather thoroughly reviewed this method of studying tumors, states that the specific sensitiveness of each kind of cell is the dominant single fact of radiology and should be recognized as a law. This sensitiveness appears to be related to the natural life cycle. Thus the lymphocytes, the metabolic cycle of which among human cells is the shortest, are also the most radiosensitive, and the nerve cells, the life cycle of which is the longest, are also the most resistant to irradiation. When, according to their radiosensitivity, certain cells or group of cells are exposed to a sufficient dose of roentgen rays or radium, the first perceptible effect is an alteration or series of changes in the nuclear portion, or genetic mechanism of the cells. Collectively, these changes are characterized by the arrest of mitotic division and by a partial or complete degeneration of the cells, individually, by disorganization and fragmentation of the nuclear chromatin, vacuolar degeneration of the protoplasm, rupture of the cell, and scattering of the fragments of chromatin from the nucleus among the cells which remain intact. He further states that

in many cases biopsy need not be done, but that correlation of the clinical, physical, roentgenologic, and radiotherapeutic evidence may often settle the diagnosis without a biopsy, or in the face of inconclusive or conflicting pathologic observations.

Ewing (2), in 1929, classified tumors in decreasing order of radiosensitivity as follows: (1) lymphoma, (2) embryonal tumors, (3) cellular anaplastic tumors, (4) basal-cell carcinoma, (5) adenoma and adenocarcinoma, (6) desmoplastic tumors, such as squamous carcinoma and fibrocarcinoma, (7) fibroblastic sarcoma, osteosarcoma, and neurosarcoma. Bloodgood (3), in 1930, published an excellent review of radiosensitive tumors, calling attention to the advantages of both surgery and radiation in the treatment of certain types of them.

In a review I made of some soft structure tumors (4), fibromas or fibrosarcomas were found to be radiosensitive or slow growing, and to fall into the group of moderate curability. One case of fibromyoma of the antrum and nares, and another case of fibromyxosarcoma involving the antrum and ethmoidal region treated with the deep roentgen ray, are up to the present time clinically well five and five and a half years, respectively. In 1933, I published a review of bone tumors which were more or less radiosensitive (5). Included in the radiosensitive group is the giant-cell tumor, particularly the variant type. Cases of cure with the roentgen ray of this type of tumor have been reported. Chondroma is partly radiosensitive, following roentgen therapy, it may recalcify, become arrested and remain quiescent for many years. Of the malignant tumors, Ewing's sarcoma and chondroblastic sarcoma are radiosensitive, secondary chondromyxosarcoma and metastatic carcinoma are partly radiosensitive. In multiple myeloma, roentgen therapy is of

¹ To be presented before the Radiological Society of North America, December 1934.



Fig 1 Case 1 Primary cancer of the breast with retraction of the nipple, palpable tumor in the breast, and enlarged lymph node in the axilla. The skin was red. Case of carcinoma *en cuirasse*.



Fig 2 Case 1 Film taken three months after the patient had received roentgen therapy. The nipple was reformed, the tumor and lymph node were not palpable. Redness of the skin disappeared. The patient is living, and there has been no recurrence of the tumor almost three years later.

value, and in some cases considerable regression and partial recalcification have been obtained.

Cancer of the breast has been found to respond well to roentgen therapy. Quick (6) reports a case of cancer of the breast that was treated with the roentgen rays alone, and is living and clinically well for 14 years. In our experience roentgen therapy has been used chiefly in post-operative cases after metastasis had developed. From 1922 to 1933, a period of 11 years, 148 patients were treated for cancer of the breast. These can be divided into the following three groups: Group I, post-operative, consisting of 130 cases. The majority of the patients in this group were referred for deep therapy after metastasis had developed; the average duration of life of 67 per cent of them was two years. The percentage who lived for three years or longer was about 33 per cent. Group II, 15 cases, all of whom were inoperable and with metastasis. Their average duration of life was 15 months. Group III, 3 cases, all of whom had primary operable cancer of the breast. This latter group while small in number is of the greatest interest. In this group, one patient was under observation for 18

months, another two years, and a third almost three years. These patients, who received no other treatment excepting roentgen therapy of 200 K V, responded excellently to radiation. The tumor in the breast and the enlarged axillary glands rapidly disappeared, and up to the present time there has been no recurrence.

One particularly interesting case, living almost three years since treatment and clinically well so far as the breast is concerned, is here reported.

Case 1. White, aged 62 years, married, had a large ovarian cyst removed six years ago. The clinical history was otherwise essentially negative. Roentgenograms of the skull, chest, spine, and pelvis were negative for metastasis. However, the chest revealed dilatation of the arch of the aorta and an enlarged heart. The patient was seen in the early part of December, 1931, by Dr. Bloodgood, who found on examination a retraction of the right nipple, and edema of the skin, with red streaks on it to the inner side of the nipple. There was a lump in the breast and a palpable lymph node in the right axilla. The diagnosis was a large infiltrating scirrhous carcinoma of the right breast, clinically malignant because of retraction

of the nipple and tumor. It was pronounced carcinoma dermatitis, beginning carcinoma *en cuirasse*. The left breast

breast practically disappeared as well as did the tumor. Also, the nipple began to reform. Three months later, a second course



Fig 3 Case 2 Large metastatic retroperitoneal sarcoma three months after surgical removal of the right testicle for embryonal type sarcoma. Pressure of this mass interfered with the filling of the pylorus and duodenum and displaced the transverse colon downward. Following deep roentgen therapy the tumor disappeared. The patient is clinically well, there having been no recurrence of the tumor after eleven years.

had a mass of the mastitis type in the center beneath the nipple and areola. There were no palpable lymph nodes in the left axilla. The patient was treated through the following four portals of entry: anterior, posterior, right and left lateral, covering both the breasts, axillæ, supraclavicular region and the mediastinum, receiving 625 r units over each portal or a total of 2500 r units. Soon after treatment the erythema of the right

of 2500 r units was given similar to the first. At this time the nipple had reformed and the tumor in the breast and the lymph node in the axilla had completely disappeared. In answer to a follow-up letter, the patient writes under date of Aug 24, 1934, as follows: "My right breast seems perfectly normal, never giving me any trouble whatever. My heart is giving me some trouble." Sampson Handley (7) states that 70 per cent of all

patients coming to operation have intra-thoracic involvement. Surgery, radium, and the roentgen ray are all used in the treatment of cancer of the breast and a combination of all three has to be used in certain cases. Cancer of the breast is a radiosensitive tumor and in my experience the roentgen ray offers much alone. In the few cases of primary cancer of the breast in which I have used it alone, the results have been encouraging. It has an advantage over other methods in being able to cover a large field, being able to include at the same time and in one treatment the breast, mediastinum, and the lymph nodes.

As a rule, the more malignant the tumor the more radiosensitive it is likely to be, for example, lymphosarcoma, Hodgkin's disease, and embryonal cell tumors. Tumors of the testicle (embryonal cell type) are especially radiosensitive and highly malignant, frequently metastasizing to the abdomen. There are, however, exceptions as to their curability, the following case being an example.

Case 2. White, male, aged 42 years, married, entered the hospital in July, 1923, complaining of pain in the right lumbar region which radiated to the right ureter. On examination, the left testicle was found to be apparently normal, the right testicle was absent. There was a large spherical mass in the abdomen which seemed to be fixed and very rigid. When palpating the kidney area on either side, the mass was near the mid-line and did not move. Roentgen examination of the chest was negative. Roentgen examination of the gastro-intestinal tract revealed difficulty in filling the pylorus and duodenum due to pressure of an extra-gastric tumor and displacement downward of the transverse colon due to pressure. An exploratory operation revealed a large mass, nodular in character, beneath the peritoneum. There was no glandular enlargement. It was impossible to move this mass freely or

to trace a direct communication with the kidneys. The mass seemed so large and so near the large blood vessels, that it was considered inadvisable to attempt to remove it. No glands could be obtained for diagnosis. From the previous history the mass was thought to be a malignant metastatic tumor, although it was impossible to obtain a section. A section from the right testicle removed in March, 1923, revealed an embryonal type sarcoma.

The patient was given deep roentgen treatments over the abdomen through several ports of entry during the months of August, September, and October, 1923, and also in October, 1924, but none since. The mass in the abdomen had completely disappeared and the patient was clinically well following the last treatment. He was seen five years later and at that time there was no recurrence of the mass and he was clinically well. In reply to a follow-up letter the patient writes on Aug 16, 1934, now eleven years since roentgen treatment, as follows: "I feel well and am able to attend to my work. There is no recurrence of the tumor in my abdomen." This case illustrates an exceptionally favorable result obtained by deep roentgen therapy in a highly malignant metastatic tumor.

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THE TREATMENT OF EPITHELIOMA OF THE SKIN

By GEORGE E PFAHLER, M D , Sc D , and JACOB H VASTINE, M D , Philadelphia

THE treatment of epithelioma of the skin is a subject that cannot be ignored even though it involves the form of cancer that is most easily controlled. There are still approximately four thousand deaths from cancer of the skin in the United States each year, a total and absolute waste of life for which there is no reasonable excuse. Forty years ago, the cure of a cancer of the skin was a real accomplishment.

cancerous lesions and the early cancers skillfully and thoroughly from the beginning so as to prevent the development of cancer, or, if it has already developed when the patient comes under the care of a physician, so that the patient can be gotten entirely well and thus eliminate this type of quack.

The Treatment of Pre-cancerous Lesions—It is general knowledge that cancer never begins in normal tissue, and certainly



Fig 1 W G male, age 83, referred by Dr W H Good May 26 1927, on account of an epithelioma involving the lower eyelid and extending toward the inner canthus, of four years' duration. Treated by radium surface application with thorough protection of the eye, eye lashes, and eyebrow. no scar. Well over seven years.

This report is based upon a study of 1,713 epitheliomas of the skin occurring in 1,385 private patients treated during the last 34 years. Of this number, 17 patients died of the cancer, we believe because they came too late. *To-day if all the knowledge that is now available is utilized skillfully, practically all cancers of the skin can be prevented, and if they are treated reasonably early, while the disease involves only the skin, practically all of them should be cured.* This fact is not sufficiently appreciated.

Among the laity, cancer of the skin is just as much cancer as is that involving any other part of the body, and the quacks usually get their following and make their money from an occasional cure of cancer of the skin. Therefore, it is most important that the medical profession treat the pre-

we have never seen any cancer that we believe originated in normal tissue. Fortunately the skin is an organ that can be easily observed by the patient and by the physician. The slightest roughness of the skin is usually noticeable by the patient, but because of the fact that there is practically never any pain or marked disturbance at the beginning of these lesions, they are frequently ignored.

Cancer of the skin nearly always develops very slowly and insidiously, so that the difference between one month and the next is not great. This fact develops in the mind of the patient a sense of indifference or security. We believe, however, that it is the duty of the physician to advise the patient to have any lesion of the skin restored to normal as promptly and as thoroughly as is possible.

Moles, and particularly the pigmented moles, may occur singly or in large numbers on a patient. They may have been

thesia at one sitting by dissection or electrocoagulation if skillfully done. If they are not already too deep, the scar follow-

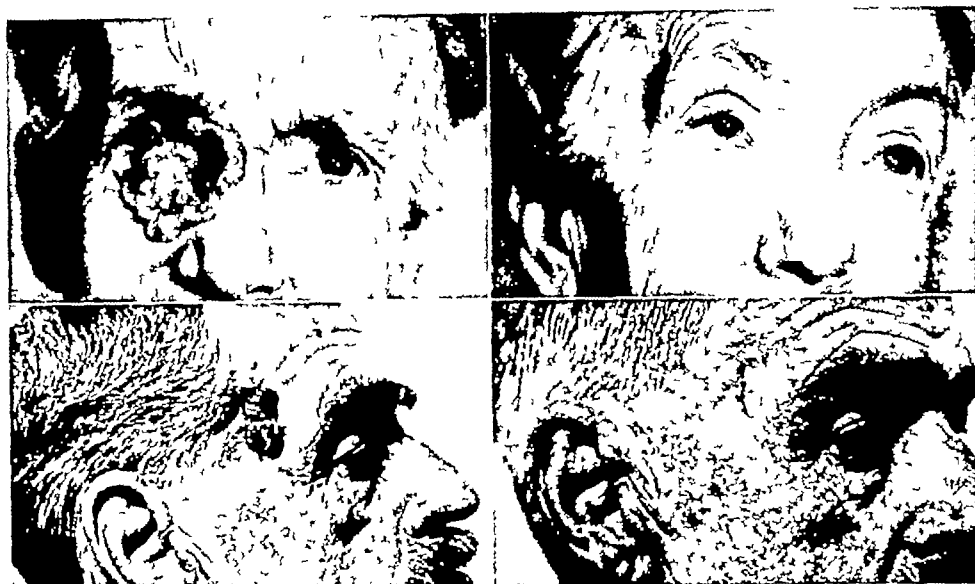


Fig 2 (above) S E female, age 85, referred by Dr J L Flanagan on June 20, 1927, on account of advanced basal-cell carcinoma of the inner canthus and lower eyelid, of fifteen years' duration. Treated by surface applications of radium, with a perfect result. Well over four years. died at age of 90 without a recurrence.

Fig 3 (below) C H H, male, age 64, referred by Dr Lyman Hollingshead, Sept 11, 1922, on account of an epithelioma involving the right temporal region (squamous-cell carcinoma). Treated by electrocoagulation and high voltage x rays applied over the neck and temporal region. This has remained well to date but on Feb 3 1933, he developed an epithelioma of the left ear, with metastasis. This too, has been treated successfully.

present early in life or may appear later in life, but we believe they are always congenital in origin. It is probably true that not more than one in a thousand, or at least one in a large number, becomes malignant, but when a pigmented mole does become malignant it is one of the most serious conditions with which we have to deal. If not treated most skillfully when the change from a benign condition to a malignant one occurs, extensive metastasis is likely to follow, and the patient is likely to lose his life. Therefore, it is probably best to remove all moles, but particularly all pigmented moles, as a precautionary measure.

Likewise, it is advisable to remove all warts and particularly senile warts, any abnormal crusts, fissures, or chronic ulcers. These can be eradicated under local anes-

ing is of little or no significance. Large scars after a period of twelve to fifteen years often develop epitheliomas, usually beginning as small fissures or erosions, then gradually spreading. This type of epithelioma is squamous-cell. Generally it is advisable to remove the entire scar by electrothermic dissection, and, if the wound is large, following that, after a period of about three weeks, by skin-grafting. Under these circumstances, we have had only one failure. Moles, warts and scars, and epitheliomas in scars are usually not successfully treated by irradiation alone, but are best destroyed by electrocoagulation.

Epitheliomas of the Skin—Epitheliomas of the skin may occur as single or multiple lesions. However, they are usually single, and usually develop on the exposed parts

THE TREATMENT OF EPITHELIOMA OF THE SKIN

By GEORGE E PFAHLER, M D , Sc D , and JACOB H VASTINE, M D , Philadelphia

THE treatment of epithelioma of the skin is a subject that cannot be ignored even though it involves the form of cancer that is most easily controlled. There are still approximately four thousand deaths from cancer of the skin in the United States each year, a total and absolute waste of life for which there is no reasonable excuse. Forty years ago, the cure of a cancer of the skin was a real accomplishment.

cancerous lesions and the early cancers skillfully and thoroughly from the beginning so as to prevent the development of cancer, or, if it has already developed when the patient comes under the care of a physician, so that the patient can be gotten entirely well and thus eliminate this type of quack.

The Treatment of Pre-cancerous Lesions—It is general knowledge that cancer never begins in normal tissue, and certainly



Fig 1 W G male, age 83, referred by Dr W H Good, May 26 1927 on account of an epithelioma involving the lower eyelid and extending toward the inner canthus of four years' duration. Treated by radium surface application with thorough protection of the eye eye lashes and eyebrow. no scar. Well over seven years.

This report is based upon a study of 1,713 epitheliomas of the skin occurring in 1,385 private patients treated during the last 34 years. Of this number, 17 patients died of the cancer, we believe because they came too late. *To-day if all the knowledge that is now available is utilized skillfully, practically all cancers of the skin can be prevented, and if they are treated reasonably early, while the disease involves only the skin, practically all of them should be cured.* This fact is not sufficiently appreciated.

Among the laity, cancer of the skin is just as much cancer as is that involving any other part of the body, and the quacks usually get their following and make their money from an occasional cure of cancer of the skin. Therefore, it is most important that the medical profession treat the pre-

we have never seen any cancer that we believe originated in normal tissue. Fortunately the skin is an organ that can be easily observed by the patient and by the physician. The slightest roughness of the skin is usually noticeable by the patient, but because of the fact that there is practically never any pain or marked disturbance at the beginning of these lesions, they are frequently ignored.

Cancer of the skin nearly always develops very slowly and insidiously, so that the difference between one month and the next is not great. This fact develops in the mind of the patient a sense of indifference or security. We believe, however, that it is the duty of the physician to advise the patient to have any lesion of the skin restored to normal as promptly and as thoroughly as is possible.

by Dr Eugene Case, but briefly, it may be stated that in this multiple epitheliomas type, one may have on the same patient

mous-cell carcinoma of the multiple type and developed metastatic lesions from which he died



Fig 6 (above) M L, female, age 75, referred by Dr Robert Parrish Sept 21, 1922, on account of an epithelioma on the right upper lip. The lesion had been growing for twenty years, but especially during the last two years. Size 3.5 X 4.5 cm, and 2.5 cm in thickness. It was beginning to ulcerate. Removed by electrocoagulation followed by x ray treatment over the lip and side of neck. Well two years at time of death from another cause at age of 77.

Fig 7 (below) E F, female, age 46 referred by Dr Peter F Moylan, Jan 18, 1926 on account of basal-cell carcinoma of the rodent ulcer type (seventeen years' duration) of the right temporal region. Treated by radium applications then by electro thermic dissection and further radium treatment. Patient is well to date after a period of eight years.

one hundred or more epitheliomas, and one may find lesions varying from the size of a pinhead to the size of a fist. This type, multiple epitheliomas, develops very slowly. In one of our cases, the patient had lesions for forty years, and they varied from a few millimeters to the size of a fist. Under general anesthesia, we removed on one day 98 of these lesions, followed by complete and permanent recovery. Fortunately, this type is usually slow in development and is nearly always basal-cell in type, but one of our patients with these multiple epitheliomas had squa-

The Basal-cell Epitheliomas Are of Two Types—In one group the typical lesion seems to develop as a papilloma, which may be small or become enormous in size. The second group shows very little overgrowth of tissue or papillomatous condition, but does show ulceration, and this represents particularly the group which has been called *rodent ulcer*. These rodent ulcer types, if treated early while they still involve only the skin, are easily cured by radium, x-rays, or electrocoagulation, but when the rodent ulcer type of epithelioma has extended into the muscle, bone, carti-



Fig 4 A G, male, age 54, referred by Dr Samuel Bennett and Dr J V Klauder, Nov 21, 1928, on account of an epithelioma, squamous-cell type, affecting the right second finger, of five months' duration, associated with an enlarged lymph node above the right elbow. Destroyed by electrocoagulation, followed by high voltage x rays covering the diseased channels all the way up to and including the axilla. Well at present over a period of five years.

of the body, but they may occur anywhere. It has been thought that epithelioma of the skin is practically always basal-cell in type. This is a mistake, for our records show approximately 15 per cent to be of the squamous-cell type, and it is well known that any squamous-cell carcinoma may give rise to metastasis. This fact must be kept in mind because in dealing with a squamous-cell type of carcinoma, one must not only treat the local lesion, but it is advisable to treat also the associated lymphatics.

The favorite locations for squamous-cell carcinomas of the skin are in the temporal region, the ear and its vicinity, the posterior surface of the hands, the genitalia, perineum, lip, and in any scar tissue, but this does not warrant us in concluding that all of these are squamous-cell nor that all other regions are not involved at times by squamous-cell carcinoma. For that reason, in practically all instances, we take a biopsy at the time of our treatment.

The treatment of epithelioma of the skin will depend in great part upon its size, depth, duration, and location. The records in the literature show that between 70 and 90 per cent of epitheliomas of the skin can be cured by irradiation, either with radium or x-rays, and this is undoubtedly the preferable method of treatment in any location where a slight scar is either objectionable or a serious matter.



Fig 5 M E H female, aged 75, referred by Dr J F Pfahler, Dec 27 1927 on account of squamous-cell carcinoma involving the right wrist, of four months' duration. Removed by electro-thermic dissection and treated by high voltage x rays over the entire arm and axilla. Well over two years died of cardiac disease at age of 77.

Since we desire to have a biopsy, however, and providing the lesion is small and located at a point where a soft pink scar is non-objectionable, it is our custom to surround the lesion by electro-desiccation, do a biopsy, and then destroy the bed of the epithelioma completely, to be followed by a full erythema dose of x-rays, or surface applications of radium. By this procedure, in cases in which the epithelioma is still confined to the skin and has not invaded the muscle, fascia, mucous membrane, or bone, we expect to cure practically all, and our records show such results. This, therefore, is usually our primary form of treatment, but if the biopsy shows squamous-cell carcinoma, then we treat the neighboring lymphatic glands by filtered irradiation, and, according to the location, by high voltage x-rays. For this purpose, we give in divided doses not less than a total of 200 per cent of an erythema dose.

Multiple Epitheliomas (Bowen's Disease)—This subject will be dealt with later in a more detailed and specific study, together with the pathologic studies made

of the dead bone. Certainly, with the present state of knowledge and skill, there should be fewer patients with such advanced disease. In the treatment of any case of epithelioma, as in the treatment of carcinoma anywhere in the body, we cannot lay down a definite rule of procedure. The plan of treatment should be adapted to the individual case, and one should keep in mind the general principles of preserving as much normal tissue as is possible to eliminate the disease as thoroughly as possible with the least loss of time, the least involvement of expense, and the least discomfort or suffering on the part of the patient.

X-ray and Radium Treatment—When one treats an epithelioma of the skin by means of either radium or x-rays, it is usually necessary to give a total of from four to ten erythema doses. The failures are usually due to insufficient treatment, or to a very prolonged treatment with insufficient dosage, a procedure which leads to the formation of much fibrous tissue embedding a few vital cancer cells. These cells later take on new growth, which explains the temporary cures and late recurrences.

If the lesion is small, one can safely give from four to six erythema doses at one sitting or at least within a few days. If the lesion is large, one must often use smaller

doses, but even then the treatment should be given within from three to six weeks. *Each case must be dealt with according to the conditions present.* One can discuss only general principles.

Good results have been obtained with soft rays and no filter, but I believe there are likely to be more recurrences when soft rays are used. We commonly use from one to two millimeters of platinum on radium even for skin cases, especially about the eyelids and inner canthus. The inner canthus lesions are markedly treacherous.

If these principles are kept in mind and we let the general public know that practically all these skin cases can be cured by the physician, or at least by a physician who is specializing in this work, then the quack will soon lose this field, and we will develop more and more prestige for the good of the profession. It is the fear of operation which, to the patient's mind, means cutting, blood, dressings, hospitalization, etc., which keeps him from coming to the physician early for the treatment of any tumorous condition. Let us eliminate this fear and we will then have an opportunity to advise the patients according to the condition present, whether it be radium, x-rays, electrocoagulation, operation, or one or more of these procedures combined.

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tory reaction about the bone. At such times it is usually possible to grasp the sequestrum with a pair of Rongeur forceps

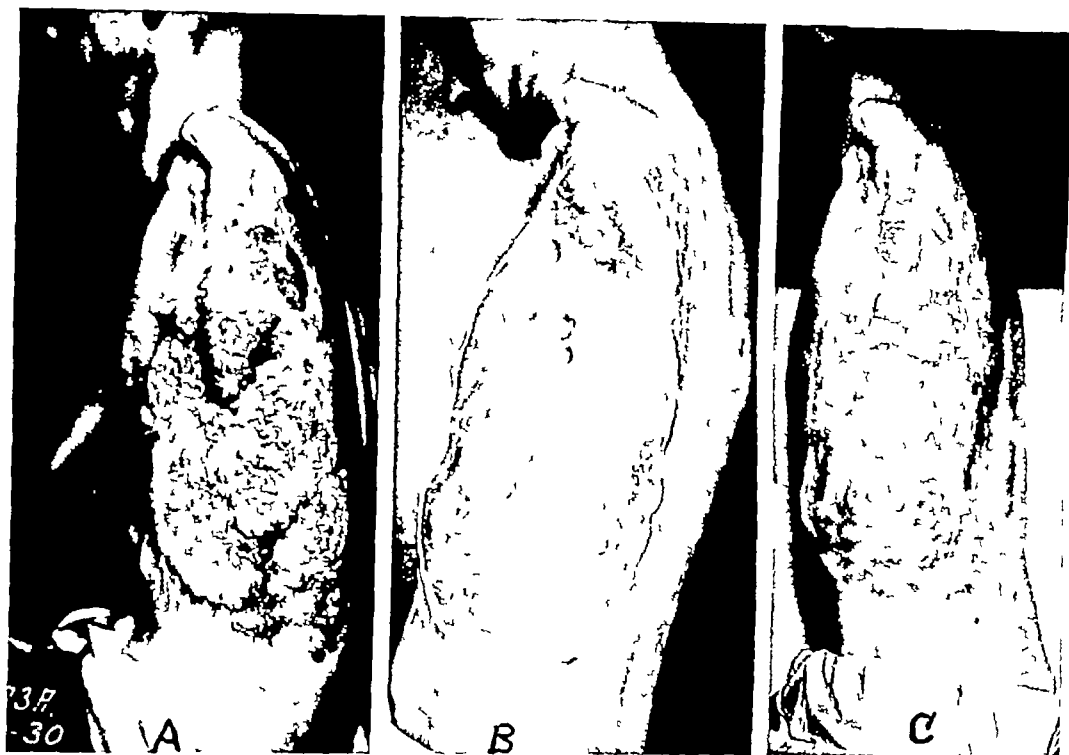


Fig 8 R D, male, age 38 referred by Dr George Reese March 24, 1930 on account of extensive carcinoma involving the remnant of the left shoulder and entire left side of the chest and upper abdomen following a severe burn twenty five years previously due to explosion of a chemical torch. In 1925 Dr Reese did a disarticulation of the shoulder. The wound never healed. Recurrent carcinoma was removed in December 1929. A recurrence was again removed March 1 1930. In association with Dr William Bates we removed the entire diseased area (Fig 8-A) by electro thermic dissection together with resection of a portion of the brachial plexus. The disease was found to be squamous-cell carcinoma Type II. The entire area was treated by radium packs. The wound is shown in 8-B. After thorough irradiation treatment the wound was grafted with skin by Dr Bates with success but the patient died Sept 20, 1931 or approximately one year and a half after beginning treatment from metastasis to the ribs and to the pleura.

by irradiation. At other times, the lesion is arrested for one year, or for several years, and then may recur. Generally speaking, it has seemed best to use electro-coagulation in this type of case, to destroy the lesion completely. Even if bone is involved, the bone area should be destroyed, and then the area destroyed should be resected down to healthy bone. If resection immediately is not practical, one may allow the destroyed bone to separate gradually from the surrounding bone, a matter which usually takes from three to six months and is indicated by an inflamma-

and lift the entire bone away. In this manner, we have removed the entire alveolar process of the lower jaw, leaving apparently a smooth and healed surface underneath.

When dealing with these deep rodent ulcer types of epithelioma of the skin, the deep involvement and erosions are usually in the neighborhood of the mastoid process, the superior maxilla, the orbit, or the nose, and in these areas it is difficult to do extensive resections. Therefore, at times, it has been our practice to destroy the disease, and then wait for the separation

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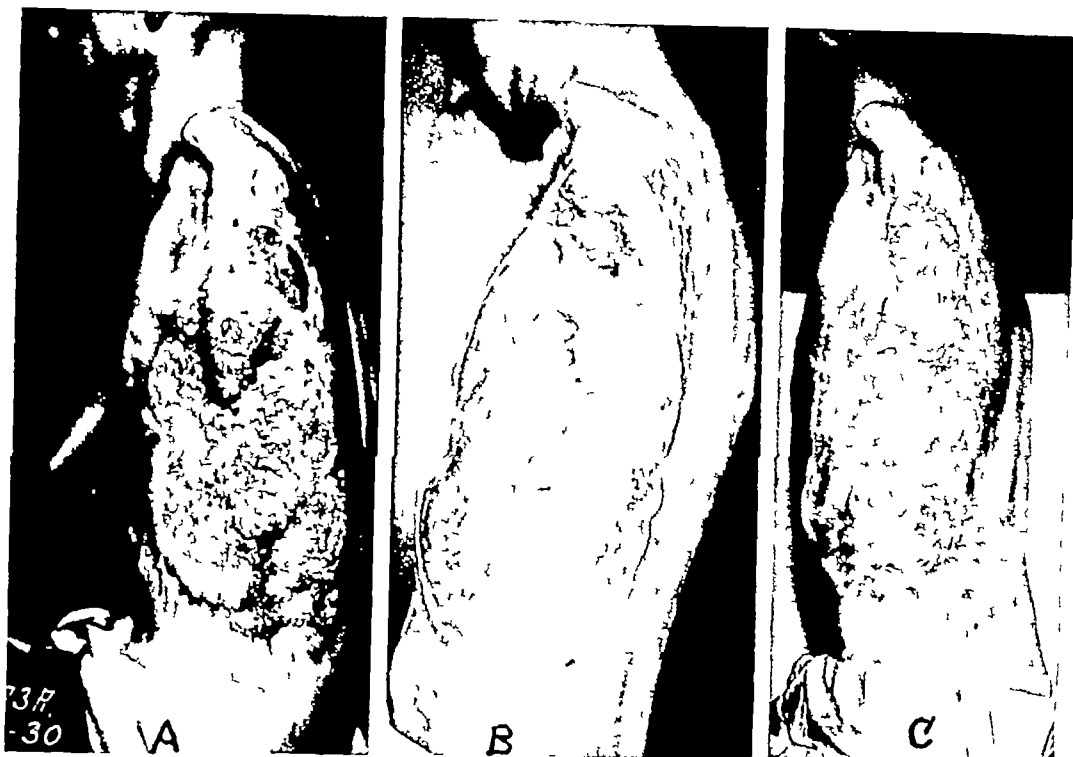


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ment for 32 hours, filtered with 20 mm brass and 30 mm para rubber, thrice at eight-day intervals or 4,800 mg-el-hrs, while the application of a single dose would be 3,600 milligram-element-hours. The distribution of gamma ray intensities is, however, very inhomogeneous. Within a radius of 3 cm from the axis of the cervix the combined roentgen and gamma dose is 4.5 TolsD and at the bony pelvic

wall about 3 TolsD. It follows that a carcinoma within a radius of 3 cm can be destroyed in the majority of cases, but beyond this radius it is only exceptional that a good end-result may be attained.

The correctness of these statements concerning adequate radiation dosage has been proven by the study of the five-year good end-results obtained in each of the clinical groups. (See Table II.)

TABLE I—FACTORS USED IN ROENTGEN TREATMENT FOR EACH APPARATUS EMPLOYED

Periods	1914-1919	1920-1921	1922-1923	1924-1932	Since 1933
Transformer	Snook	Cross arm Type A C	Cross arm Type A C	to deliver 280 K V (max)	Pulsating current to deliver 800 K.V (max)
Kilovoltage (max)	110	140	211	211	800
Type of Tube	Standard focus	Coolidge with broad focus	Air-cooled 200 K V Coolidge	Water-cooled 250 K.V Coolidge	Water-cooled four section Coolidge
Filters	6 mm Al	0.5 mm Cu + 1.0 mm Al	1.0 mm Cu + 1.0 mm Al	1.0 mm Cu + 1.0 mm Al	1.5 cm water 1.5 mm brass 2.0 mm Al 1.0 mm Pb 3.0 mm Cu 1.0 mm Al 5.0 mm bakelite 7.7 mm Cu
H.V.L.			1.2 mm Cu	1.85 mm Cu	7.5 cm
F.S.D.	25 cm	65 cm	65 cm	80 cm	75 cm
Size of Field	5 × 5 cm	15 × 15 cm	15 or 20 × 20	15 or 20 × 20	15 or 20 × 20 or 25 cm
Number of Fields	8 to 20	2 to 5	2 to 5	2 to 5	2 or 3
Ma	5	5	5	25	10
Fractions	3	3	0	5 to 10	10
Intervals	3 days	3 days		2 days	2 days
Depth Dose at 10 cm	20%	32%	44%	46%	54%
r with back-scatter to each field		750	900	1,500 with 5 fractions 2,500 with 10 fractions	10 × 280 r

TABLE II—THE FIVE-YEAR GOOD END-RESULTS FOR EACH CLINICAL GROUP AND PERIOD IN PRIMARY CARCINOMAS OF THE UTERINE CERVIX

Period	1914-1919					1920-1921				
Clinical Group	1	2	3	4	Total	1	2	3	4	Total
No admitted	5	16	76	35	132	9	13	26	29	77
No 5-year end results	5	7	7	0	19	6	6	2	0	14
Percentage 5 year end-results	100 0	43 75	9 21	0	14 39	66 67	46 75	7 69	0	13 38
Period	1922-1923					1924-1929				
Clinical Group	1	2	3	4	Total	1	2	3	4	Total
No admitted	9	19	59	36	123	23	36	100	116	275
No 5 year end results	7	7	11	0	25	21	19	30	7	77
Percentage 5 year end results	77 78	36 84	18 65	0	20 32	91 3	52 78	30 0	6 04	28 0
Grand Total, 1914-1929										
Clinical Groups	1	2	3	4	Grand Total					
No admitted	46	84	261	216	607					
No 5-year end results	39	39	50	7	135					
Percentage 5 year end results	84 77	47 62	19 16	3 24	22 26					

RADIATION THERAPY IN CARCINOMAS OF THE UTERINE CERVIX¹

By HENRY SCHMITZ, A M , M D , L L D , F A C S , F A C R , *Chicago*

From the Department of Gynecology of Loyola University School of Medicine and the Mercy Hospital Institute of Radiation Therapy, Chicago

THE five-year good end-results of radiation treatment in carcinomas of the uterine cervix are contingent on the size of the growth and on an adequate radiation dose. The histologic malignancy index and the constitutional or systemic reaction, also, influence the percentage of good end-results. However, the relation between these last factors and the results of treatment has not as yet been definitely confirmed. The extent of the tumor and the technic of radiation therapy and their influence on the five-year good end-results will be briefly described.

The extent of the growth is expressed in four clinical groups

Clinical Group 1—The clearly localized growth. It is on an average about 1 cm in diameter in all directions.

Clinical Group 2—The doubtfully localized growth. It is characterized by an edema or infiltration of the paracervical connective tissue and hence a decrease in the degree of downward displacement of the uterus.

Clinical Group 3—The invasive growth. It is marked by definite invasion of the parametria or regional lymph nodes, but the invaded structures are movable, though movability is decreased, due to loss of elasticity of the tissues of the parametrium.

Clinical Group 4—The fixed and terminal growth. It is distinguished by fixation of the tumor, due to invasion of the deep visceral and parietal pelvic fasciæ, or invasion of the vagina, urinary bladder or rectum, or the formation of distant metastases.

The clinical grouping is used in most of the gynecologic clinics in the United States of North America. It is based entirely

on the clinical findings and prevents a subjective interpretation of the extent of the growth. The terms "operable," "borderline," and "inoperable" carcinomas lead to subjective interpretations varying with the surgical judgment and technical ability of the gynecologist.

An adequate radiation tissue dose means a homogeneous impregnation with a predetermined radiation dose of the entire true pelvis. The tumors of Clinical Groups 1, 2, and 3 are confined within the true pelvis. The limits of the radiation dose are set by the tolerance of the normal tissues and by the quality of the roentgen rays.

The tolerance of the normal tissues has been termed the "Tolerance Skin Dose" (Tol S D). The threshold skin dose produced with 200 K V maximum is 600 r with back-scatter. The erythema skin dose produced with the same dose of roentgens is 900 r with back-scatter. The tolerance skin dose used in our work and applied with the same roentgen dose is 1,350 r with back-scatter. The doses should be given in one sitting. If fractionation is employed, using ten equal fractions every other day to a field, then the total dose of 2,700 r with back-scatter may be applied to produce a tolerance skin dose. Hence it is evident that the distribution of roentgen dosage through two fields in a patient with an anteroposterior pelvic diameter of 20 cm is practically 1,500 r if applied in one sitting, and 2,700 r if applied within 21 days, giving to each field ten fractions of 250 r plus every other day, thus attaining about 3 Tol S D in the midpelvis. However, about 4.5 to 5 Tol S D constitute an adequate tissue dose for uterine carcinomas. The deficiency is supplied by the intracervical insertion of 50 milligrams of radium ele-

¹ Read at the Fourth International Congress of Radiology, Zürich, Switzerland, July 24-31, 1934.

NEW ENCEPHALOGRAPHIC TECHNIC INSUFFLATION OF AIR BY THE DOUBLE PUNCTURE METHOD—CISTERNAL AND LUMBAR COMBINED¹

By DR MARIANO R CASTEX, Member of the Academy of Medicine and Professor of Clinical Medicine, and DR. LUIS E. ONTANEDA, Venia Doctenti of Clinical Medicine and Chief of the Clinical Service at the Central Military Hospital, Buenos Aires, Argentina

IN ONE of our previous papers (Castex and Ontaneda, 1932), we pointed out the serious inconveniences brought about by the technics used up to the present for the insufflation of air for encephalographic purposes. In synthesis, we could state that the fundamental principles generally used for such technics, with a view to causing the least possible change in the endocranial pressure, are based on two different procedures

- 1 To inject approximately the same amount of air as corresponds to the quantity of cerebrospinal fluid having been extracted

- 2 To insufflate as much air as is necessary to keep the lumbar tension at the end of the operation at the same level as it was before the operation

With the exception of a few authors who make use of more or less ingenious apparatus, tending to avoid the sudden tension changes during the substitution of liquid for air, the majority employ a simple syringe which draws in the liquid and insufflates the air. Those using this procedure come to face sudden tension changes with every extraction of liquid and with every injection of air.

But, even if we suppose that the use of an ideal apparatus or appliance would eliminate the sudden changes, by the lumbar method, the insufflation will not take place without having generally caused a tremendous hypertension in the endocranium. In fact, it is well known that the pressure of the liquid, when we consider a patient as standing up or sitting, is so much less as a higher region is considered. We can briefly say that in such a position

the normal patient has the following approximate tension

Ventricular	—10 cm of water
Cisternal	—0 cm of water (3)
Lumbar	+40 cm of water

So, even when using what seems to be the ideal technic (constant maintenance of the initial lumbar tension during the insufflation), as soon as the operation is finished there takes place a tremendous hypertension. Let us suppose that we have extracted the whole amount of liquid and substituted air. Having done this, we have placed the whole ventricular-subarachnoid space at the tension similar to the initial lumbar tension, that is, 40 cm for the example we have in mind. That is to say, the ventricles are subjected to an air pressure of 40 cm, or 50 over the initial reading, and, in fact, so tremendous as would most certainly not be produced by the largest tumor. Naturally, by failing to completely drain all the liquid out of these spaces, pressure changes will be less noticeable, but nevertheless of considerable importance.

To sum up, we can say that the causes that bring about disappointments and inconveniences by insufflation of air, in order to secure encephalograms, are subjected to the following

- 1 The same presence of air which produces a meningeal and ependymal irritation, independent of its pressure,

- 2 The sudden pressure changes, when extracting cephalo-rachidial liquid and insufflating the air,

- 3 The heavy cranial hypertension caused by the exchange of liquid for gas

Insufflation by the cisternal method is less dangerous and less bothersome inasmuch as, the sub-occipital tension being so

¹ Presented before the American Congress of Radiology at Chicago Sept 25-30 1933

Another observation resulted from this study. The number of five-year good end-results increased with an improvement in the roentgen apparatus and tubes, as seen from Tables I and II. The radium technic of application has remained the same throughout the years. Therefore, increase in the absolute percentage of the five-year good end-results should be attributed to the progress in the development of roentgen and tube equipment and technic of application. The installation of an 800 K V (max) transformer should improve the five-year good end-results so far attained. The factors used in the application of the 800 K V roentgen dose are seen in Table I.

The fractionation of the treatment could

not account for the gradual improvement of the results, as we have practised fractionation in radium and roentgen therapy since 1914. Protraction was found to be not necessary in carcinomas of the uterine cervix. The daily application of radiations, either radium or roentgen, over 24 to 30 days assures the best and continuous distribution of electrons within the tumor-bearing area.

The substitution of the "tolerance tissue dose" for the threshold or erythema skin dose and the improvement of apparatus and tubes—and hence technic of treatment and more favorable distribution of radiation intensities—are some of the main factors to be considered in radiation therapy of uterine cancers.

terna magna there is always a lesser tension than is to be found in the lumbar (in normal persons at this high level, while sitting, the tension is either negative, up to 5, null or positive, up to 5 cm, practically null), we made a double puncture, lumbar and cisternal. The liquid would flow through the lumbar needle, while the ambient air would automatically pass through the cisternal needle, inasmuch as the loss of lumbar liquid would cause cisternal hypotension, which, in turn, would "inhale" the atmospheric air, thus keeping the cisternal tension even with that of the atmosphere. This procedure is advisable only in patients whose cisternal tension is very close to normal, that is to say, 0, or the same as the atmosphere. In patients with a negative tension, this is increased to 0. This inconvenience does not amount to anything, on the contrary, in hypertensive patients, it is necessary to allow the flow of cisternal liquid until the cisternal tension equals that of the atmosphere. It will be understood that it is a serious inconvenience when we are dealing with cerebral tumors. Therefore, this procedure is advisable only for non-hypertensive patients.

After further trials, which we choose not to describe in order not to lengthen this paper too much, we reached what seems to us to be the definite conclusion, and which we shall now proceed to explain.

PROCEDURE

We have already stated that at the level of the cisterna magna there is always a lesser tension than the lumbar, while the patient is standing up, no matter what the value of endocranial pressure may be. Then it will be understood that if two needles are placed in combination, one inserted deeply into the lumbar cavity and the other into the cistern, with a container filled with air, the lumbar liquid, due to its higher pressure, will come into the container, thus dislodging the air in it, which automatically will ascend through the tube connected to the upper needle. It will then pass into the cistern, and from here to



Fig 2

the endocranium. The amount of lumbar liquid passing into the glass container will be similar to the amount of air emanating from it and passing into the cistern, without the necessity of removing one nor insufflating the other.

In order that the cisternal tension shall be maintained constant during this operation, it is necessary that, before the lumbar liquid comes out, the air in the container must have the same pressure as the cistern. In this way the whole system will function at a constant tension, subjected to minute changes which are practically disregarded during the course of the operation.

Apparatus—During practice, a glass container or, still better, one of the small

much more like the ventricular than the lumbar, the final air pressure obtained is similar to the initial one of the cephalorachidial liquid in the endocranium. And as the vital centers are to be found in the

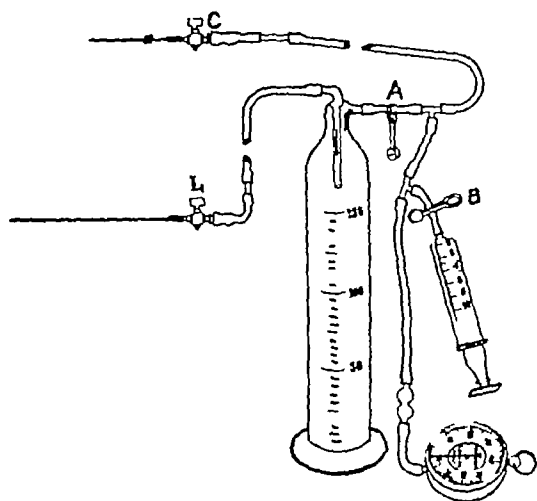


Fig 1

encephalus and not in the spinal cord, it will be understood why we should concern ourselves with the maintenance of a constant or almost constant ventricular tension rather than the lumbar

But the methods commonly used for the insufflation of air by the cisternal method, based upon the extraction of liquid and the injection of air, as when the operation is done by the lumbar method, have the serious inconvenience of occasioning tremendous tensional oscillations in every replacement of liquid for gas. Furthermore, it is constantly observed that after injecting 10 to 15 c c of air, the following drawings made by the syringe secure liquid only after a certain amount of air has entered in it, inasmuch as the air fills the cisterna magna before passing into the endocranium. It is worth while to mention that in the successive exchanges it becomes necessary to draw as much as 20 c c in order to obtain from 5 to 8 c c of liquid. The balance (15-12 c c) corresponds to the air that returns to the syringe and has to be re-injected. Therefore, if toward the end of the

operation the cranial tension is nearer to the primitive value than when working by the lumbar method, the tensional disturbances with every extraction-insufflation will be greater due to the larger amount that has to be drawn with the syringe with every manipulation.

OUR EXPERIMENTS

For the last six years we have been practising encephalography by cisternal procedure, after having forsaken the lumbar method due to the serious accidents resulting from it. At first we used the common technic, removal of liquid or injection of air, and although neither one completely satisfied us, to do so turned out much better than to use the lumbar procedure inasmuch as the patient could stand it better, and we found it necessary to use a smaller amount of air in order to secure satisfactory encephalograms.

We have tried at various times to improve the technic. Once we tried to insert two needles into the cistern. One of them was used in conjunction with a 20 c c syringe for the injection of air, and the other was attached to a rubber tube, ending in a shorter one made of glass. Both were filled with physiological serum and were raised or lowered so as to avoid the leakage of serum to the outside or into the cistern. In other words, the serum level was set at the necessary height in order to neutralize the pressure of the liquid within the cistern. Air was injected with a syringe. Cisternal tension was increased, and, under this condition, first serum and then the liquid would pass through the tube and come out by the free end of it until the equilibrium of the primitive tension was obtained without greatly changing the tension in the endocranium. We forsook this procedure because soon after the passage of the liquid, air would begin to leak from the tube, due to the fact that, as we mentioned before, the air is first concentrated in the posterior cistern before passing into the endocranium.

When this procedure failed, we adopted another one. Considering that in the cis-

the bottle, down to a level just above the top of the graduate scale, so that the dripping of the fluid can be seen (Fig 1) The outlets of this ampule are connected to the tubing which runs to the needles The rubber tube corresponding to the lumbar needle (*L*) is connected to the outlet which prolongs itself into the container The rubber tubes, measuring 30 to 35 cm for the lower needle and from 60 to 70 for the upper, are connected to large manometers by means of "T" glass connectors One of these instruments registers the lumbar tension, while the other registers the cisternal tension In fact, practice calls only for the cisternal manometer For this purpose we make use of a special manometer² which registers both the positive tension (up to 40) and the negative (up to 30) in centimeters of water When this manometer cannot be had, simply use Claude's instrument, which although it does not register the negative tension, does register the true tension when it is most desired, that is, whenever there is any cranial hypertension The tubing leading to the cisternal manometer is provided with a "T" connector (*B*) by means of which a syringe can be attached to the system Whenever it becomes necessary to interrupt the passage through the needles, this can be done by means of the two petcocks (*C* and *L*), or otherwise, by making use of two Mohr's forceps

Technic—After the routine sterilization of materials by boiling, the operation is started Having duly prepared the patient with the aid of the anesthetics and other sedatives commonly used (and if he has cranial hypertension he should be given the generally used hypertonic solutions), he is seated on a chair in such a way that the chest rests against the back of it The rubber tubes are connected to the glass container, and then the procedure is as follows

1 Make the lumbar puncture on the point of choice and connect the needle to the petcock *L* before perforating the dura,

so that no liquid will escape Petcock *L* should be closed

2 Then make the cisternal puncture³ and connect the corresponding needle to the open petcock *C*, while the passage to the container is interrupted by means of forceps *A* In this way the manometer will register the cisternal tension

3 In order to obtain within the container a tension similar to that of the cistern, we must proceed as follows Isolate the cistern by closing petcock *C* The glass container is then directly connected to the manometer and syringe by releasing the forceps *A* and *B* With the syringe air is either withdrawn from or injected into the bottle, as the case may be, till the tension in it equals that of the cisterna magna Then, by opening petcock *C* a direct connection is established between the cistern and the manometer and glass container

4 By opening petcock *L* a closed circuit is established between the bottom of the lumbar cavity and the cistern, the cerebrospinal fluid passes through *L* and goes into the container by replacing the air in it and expelling it toward the cistern, from which place it goes into the endocranium, without altering the cisternal tension, as can be seen in the manometer

5 Then, slowly, the desired amount of liquid is allowed to flow into the glass container, generally about 50 c.c. is sufficient A similar amount of air is allowed to go into the cistern It has been found convenient to close petcock *L* every time 15 or 20 c.c. of air has passed through, so that the air penetrates slowly into the ventricles

An increase in tension as registered by the manometer can be caused by (a) the patient's efforts due to discomforts,

³ In order to make the cisternal puncture we apply our own technic which allows one (a) to outline exactly the point of entry (b) to determine in each case the skin-dura mater distance that is, the length of needle to be inserted, (c) to show the exact direction in order to reach straight and exactly, the occipito-atloid space and to show at any time the exact location of the end of the trocar within the tissues it traverses

² Manufactured by Boullite, of Paris

ampules (150 to 200 c c) used for physio- physiological serum in that it is elongated, logical serum, has been found to be satis- graduated from 10 to 10 c c up to 150

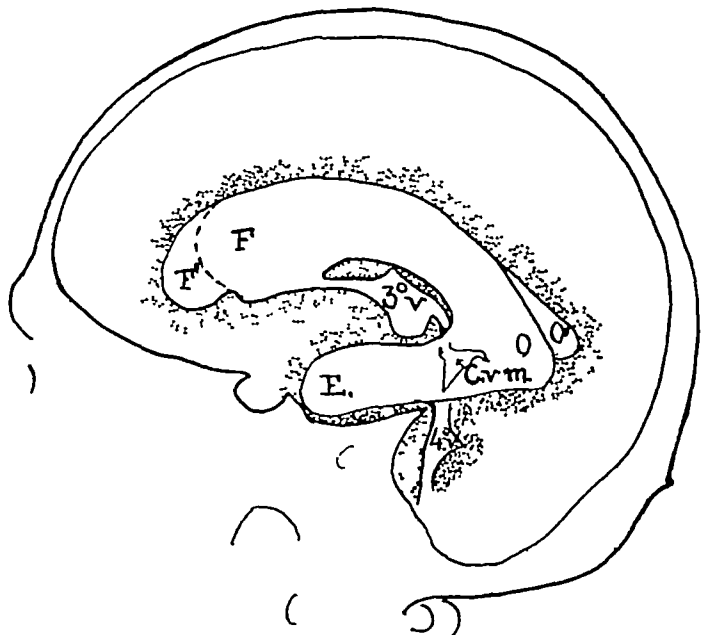
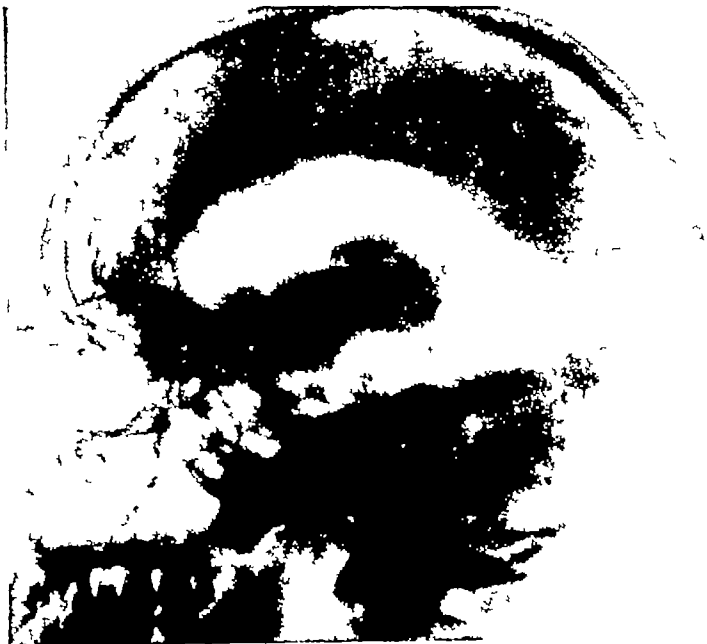


Fig 3

factory We ordered a special ampule c c , and the tube, which continues one of which differentiates from those used for its two openings descends from the neck of

2 We hereby submit a technic based on the existing difference of tension between the fundus of the dural cavity and the cisterna magna, when the patient is sitting up

3 The principle of this method is that, if a glass container filled with air is connected to a needle inserted into the cistern and another needle in the dural cavity, the lumbar liquid will pass into the glass container due to its higher pressure, will dislodge the air harbored in it, and then will send this air into the cistern and finally into the endocranium, without practically altering the endocranial tension

4 The results obtained by this method in about a hundred cases are very satisfactory, and we believe that it is just as much

or more innocuous than ventriculography and much more than encephalography, thus compensating for its greater technical complexity

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 - (3) IDEM Cerebrospinal Fluid Tension within the Cisterna Magna Prensa Méd Argentina, 1932, 18, 1473
 - (4) IDEM Ponction Cisternale Doum, edit, Paris, 1934
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(b) the existence of a small amount of water in the cisternal tubing which disturbs the air advance, (c) the fact that the cisternal needle is not *in situ* or has come out of its place. This last occurrence is immediately detected, in fact, in the first two instances there has been a slight increase, while in the last one the increase lasts for some time, and continues the upward trend until the pressure within the container is so great that it stops the extraction of lumbar liquid. Under this circumstance it will suffice to re-insert the end of the needle in its place, and at once it will be noticed that the tension is coming down to its original value.

6 When the insufflation is finished, proceed to close petcock *L* and then withdraw the needles, to be followed by the taking of radiographs after a lapse of about an hour for better results (thus allowing for the maximum penetration of air into the ventricles).

Results—It will be seen that during the course of the operation there occur no tension changes at a level with the cistern, and whenever all the technic requisites have been fulfilled, the oscillations of the cisternal manometer are practically depreciated, as they are not more intense than the physiological ones generally observed. However, as it is logical to expect, the lumbar tension begins to descend as the liquid is drawn out, inasmuch as its height along the column diminishes in the dural sac. By drawing out a small amount of liquid, this lumbar tension descent will be very slight and can always be depreciated, since, what really interests us is not to maintain a constant pressure on the spinal cord, which lacks vital centers, but, rather, to uphold it wherever those centers exist, that is, in the ventricular walls and in the endocranium in general.

Up to the present time we have done about a hundred encephalographies by this method (25 on patients with cerebral tumors, and some of them in the posterior cranial fossa), without having to record up to this time any regrettable developments

that could be blamed directly on the operation.

During the insufflation the discomforts and objective symptoms are light, when compared with what we are accustomed to see when the common technics are used. Although cephalæas are ever present, they are less intense, while at the same time it is impossible to suppress them wholly, due to the fact that in part they are derived from the irritating action of the air. Such common phenomena as vomiting, perspiration, etc., are less frequently noted. Radiographs are easily obtained, due to the better tolerance of the patients.⁴ The post-operative period offers a little more discomfort than generally is noticed under the common rachicentesis, but the patient is mostly able to get up between the second and fourth days after the operation. We have never seen any disagreeable sequelæ, but instead we have recorded improvements or cures, as other authors have described, as a result of air insufflation.

The radiographs obtained leave nothing to be desired. The filling of the ventricles and of the subarachnoid spaces has been accomplished with the efficiency expected from the usual technics. In short, we believe that our technic offers the security of ventriculography, with the simplicity of encephalography.

SUMMARY

1 The insufflation of air by lumbar procedure, according to the methods used up to this time, causes intense endocranial tension changes, thus accounting for intense subjective discomfort, and very frequently causes serious and sometimes fatal accidents. Although it seems that the technics employed are quite perfect, there constantly develops an intense endocranial hypertension.

⁴ With a view to disturbing the patient the least and injecting strictly the necessary amount of air so that the most desirable radiographs are obtained, one of us (Ontaneda) has designed a chair which allows the satisfactory fulfillment of all the requisites involved. The description of this chair will be presented in a separate paper (Fig. 2).

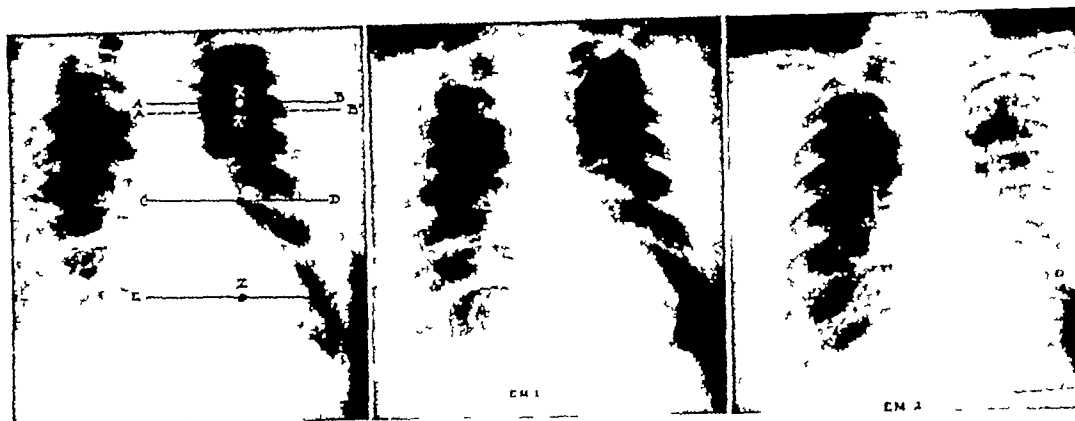


Fig 1 Points chosen for estimation of depth doses

Fig 2 Case 1 Chest before treatment

Fig 3 Case 1 Two months after the first treatment cycle, at beginning of second

except for brief comment, and confine my detailed description to the four that seem most clear-cut. Two of these four had very large doses, one, having extensive recurrence after simple mastectomy, received a total of 9,850 r (measured in air) over the thorax through four portals, and another, classed as primary inoperable, a total of 13,450 r also through four portals. A third received only 7,800 total r through five portals, but she was a very thin woman, with narrow sagittal chest diameter. I realize that statements of "total r" have no place as accurate description of treatment, but they are used here to indicate proportions only, their distribution being given below. The fourth of my cases received much less treatment into the lung than the others, but as she showed changes similar to those most heavily treated, I present her for the sake of a certain correlation which she suggests. My criteria for considering the pulmonary and pleural changes non-malignant are

1 The process developing within a certain time relation to treatment, the chest having been clear at the commencement of treatment, and such process remaining stationary or regressing over periods of six months to one year

2 An autopsy obtained in one of the cases that died subsequently of lobar pneumonia on the opposite side

However, my primary interest is not so much in pathologic, clinical, or roentgen proofs of the condition itself, all of which have been adduced before, as in offering quantitative information, even though in but four cases, of carefully measured doses delivered *into* the lung, producing under described conditions certain definite effects. My depth dose measurements have been obtained with the aid of Mrs Edith Qumby, of Memorial Hospital. The figures are based, not on water phantom or special phantom measurements (6), but on the work of Mrs Qumby and Dr Copeland (9) on radiation of the lungs of the cadaver, as presented at the First American Congress of Radiology in Chicago in September, 1933

TECHNIC

K V—200 (peak),
ma—30,
Target-skin distance—50 cm,
Filter—0.5 Cu and 2.75 Al,
Intensity—62.5 r per minute,
Unit of dosage—1 threshold erythema dose
(T E D) = 500 r measured in air

POINTS CHOSEN FOR ESTIMATION OF DEPTH DOSE (FIG 1)

Plane AB passes horizontally through the articulation of the first rib anterior,

CHANGES IN THE LUNGS AND PLEURA FOLLOWING ROENTGEN TREATMENT OF CANCER OF THE BREAST BY PROLONGED FRACTIONAL METHOD¹

By HARRIET C. MCINTOSH, M D, *New York City*

THE recognition of the condition of pleuropulmonitis following roentgen treatment of the thorax for cancer of the breast and intrathoracic malignancies is not new. The condition was first definitely pointed out by Groover, Christie, and Merritt in 1922 (1), but the descriptive term "pleuropulmonitis" by which it is now best known was first applied by Desjardins (2). In the five years between 1922 and 1927 a considerable number of papers and discussions were contributed on the subject (3). The thought was at first expressed that the growing number of cases, where none had been previously reported, was related to the use of copper filtration, with the greater depth dose resulting. The first commentators used an average of 135 K V P through 0.5 Cu. Tyler and Blackman (4), in the same year, used 6 mm Al, as did Davis (5), and in 1925 Evans and Leucutia (6) reported intrathoracic radiation changes from both superficial and deep therapy, and stated that the quality of the rays had no influence, that the effect was a quantitative one only. Desjardins (2) and Groover, Christie, Merritt, and Coe (7) believe that the element of wave length has a very limited effect on the process and that the chief factor is quantitative. A review of the literature of the subject is not indicated here. Bibliographies are at hand by Davis (5) up to 1924, by Karlin and Mogilnitzky (8), and by Desjardins (2), up to 1932, the last being the most extensive. Neither this material nor my own search of current literature of the last two years discloses specific reports of lung changes arising from the employment of the prolonged fractional method, with high total r,

which has recently come into use for the treatment of inoperable mammary carcinoma. A few such cases, with careful depth dose estimations, will be presented herewith.

The importance of the subject rests upon two factors. First, there is the question of morbidity and possible mortality ensuing from these lung changes. This will be discussed later. Second is the difficulty of differentiating between radiation change and advancing metastasis, especially in cases in which more treatment for palliation of the metastasis might be contemplated. A curious feature of the situation is that although the condition is unhesitatingly recognized by many roentgenologists, it is almost categorically denied by others, quite regardless of the large number of animal experiments published, and a considerable body of clinical reports. I have heard two chiefs of large and active radiation clinics state that they have never in their own experience seen a case of radiation damage of lungs that they considered satisfactorily proved, that all cases in which they suspected radiation change, later turned out to be metastasis. A number of others have expressed various degrees of skepticism—this in the face of the fact that the technic of tangential radiation for carcinoma of the breast, devised by Holfelder and by Finzi for the avoidance of just such intrathoracic damage, is in wide use.

My material consists of eight cases treated in the Strang Clinic of the New York Infirmary for Women and Children, showing what I believe or know to be radiation changes in the lungs and pleura. However, one of these certainly, as shown at autopsy, and three more possibly, are complicated by the presence of metastases, so that I prefer to set them aside,

¹ Read in part before the Fourth International Congress of Radiology, Zurich and St. Moritz, Switzerland, July, 1934.

height of the skin changes, with roentgen changes manifested shortly thereafter. In this case the patient showed erythema but chiefly by the fact that the patient was slight and thin, her sagittal chest diameter small.

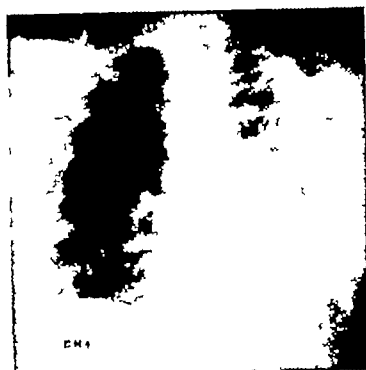


Fig 4 Case 1 Three months after first cycle, one month after second



Fig 5 Case 1 Eight months after first cycle, six months after second

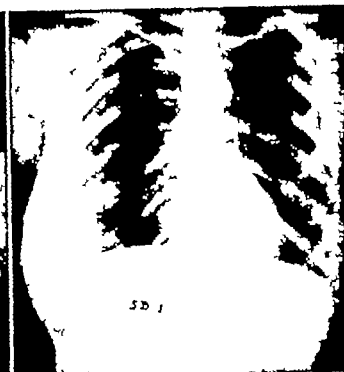


Fig 6 Case 2 Chest before treatment

before the end of the first cycle, followed by complete superficial desquamation during the next two weeks, with restoration of normal skin in about thirty-five days, but throughout this and the ensuing interval before the second cycle, she remained symptom-free. The second cycle, much smaller, with no skin reaction whatever, seems to have set off a fuse which exploded into an acute lower respiratory episode, evidently a bronchopneumonia. Desjardins has stated that reactions are unlikely to follow the first series, coming usually not before the third, while Groover, Christie, Merritt, and Coe find reactions in their group chiefly after the first series. They also state that they now (1927) find that symptoms and signs come on later than they at first reported, only attracting attention two to three months after treatment.

Case 2 This case is not a carcinoma of the breast, but is utilized because of the patient's reaction to thoracic radiation. A young woman, 28 years of age, was admitted in April, 1933, with melanoma of the right scapular region with metastasis to the right axilla. The treatment was on a palliative basis. The relatively high depth doses obtained are to be explained partly by the five portals used (for cross-firing),

Radiation Received—Daily treatments five portals, one portal treated per day, 300 to 500 r per portal.

Total 1,300 r on each of two portals
1,400 r on each of three portals

Total r employed on hemithorax 6,800 r

Depth doses at designated points (see Fig 1)

at X—4 2 T E D
at X'—4 5 T E D
at Y—4 5 T E D
at Z—2 9 T E D

Figure 6 shows the chest before treatment, lungs clear. A film made six weeks after treatment, not offered here because the change is too slight for certain reproduction, showed a barely perceptible haze over the whole right lung-field. There were no pleuritic pains or other symptoms. Three months after treatment (Fig 7) there is definite homogeneous clouding of the right lung-field, with only slight increase of the right hilum shadow and larger peribronchial markings. The process was interpreted as primarily a pleural reaction. The patient was still symptomless. A film made five months after treatment showed the right lung to be practically clear. A few weeks later, during a spell of cold and stormy winter

plane *CD* through the third rib anterior, plane *EF* through the fifth rib anterior

X, *Y*, *Z* represent points halfway through the chest from front to back on planes *AB*, *CD*, *EF*, respectively. *X'* represents a point one-third the distance from the front on plane *AB*. This point was added because most of the radiation for breast malignancy converges onto the lung from the front. An unlimited number of points could, of course, have been chosen, but for practical purposes, these seemed representative.

PRESENTATION OF CASES

Case 1 Woman of 63, with recurrent carcinoma of left breast with axillary metastases. Simple mastectomy in another hospital in July, 1930. Admitted to Strang Clinic in July, 1933, with diseased tissue all along the scar of previous mastectomy and filling the axilla. Left supraclavicular region showed suspicious fullness, no discrete nodes. Received roentgen treatment only. She was treated through four portals, as follows:

Course 1 Daily treatments of 200 r to each of two portals

Duration of treatment—24 days

Amount of treatment

2,250 r to anterior chest

1,900 r to supraclavicular portal

1,900 r to axilla posterior

1,300 r to axilla direct

Depth doses at designated points (see Fig. 1)

at *X*—5 T E D

at *X'*—6 5 T E D

at *Y*—3 5 T E D

at *Z*—2 1 T E D

Course 2 Two months later. Two and one-half T E D given on each of two fields directly over regressing metastases, averaging 1 T E D at each of points *X*, *Y*, *Z*.

Following this the masses completely disappeared, and the patient has remained clinically free of carcinoma for one year.

Figure 2 shows the chest before treatment. The lungs are clear, no metastases are seen. Note sclerotic plaque in aortic arch. Figure 3 shows the condition two months after the first cycle, at the beginning of the second. There are seen increased peribronchial markings in the treated area, faint patchy infiltration of the parenchyma adjacent to the hilum, and a diffuse haziness in the axilla suggestive of thickened pleura. During this two-month period the patient had been in good health, with no cough, chest pains, dyspnea, or other symptoms. Figure 4 shows the condition three months after the first cycle, one month after the second. There is increase of all the findings noted in the previous film. Two weeks before this film was made, the patient was ill for one week with chills, fever, cough, and pleuritic pains. Physical signs at the time the film was made: dullness, bronchovesicular breathing, moist crepitant râles from clavicle to fourth rib anterior, from fourth to seventh vertebral spine posterior. Symptoms: productive mucoid sputum, morning cough. Otherwise the patient feels well. Films have been taken monthly to the present time. Figure 5 shows the condition eight months after the first cycle, six months after the second, with about 50 per cent clearing as compared with Figure 4. There is still slight cough and productive sputum in the morning, with dullness and harsh breathing from the clavicle to the fourth rib anteriorly. The patient looks well, feels well, and has gained weight.

The sequence of these changes should be noted. No symptoms were experienced by the patient and only slight roentgen damage was seen following the first cycle, which, as far as I can estimate from data given, probably represented heavier depth radiation, though by different technic, than any previously reported. The early commentators, Groover, and Case, discussing Tyler and Blackman's paper (4) and Groover, Christie, and Merritt (1) mention cough, and even actual pneumonia, occurring ten to fourteen days after the end of the treatment, frequently at the

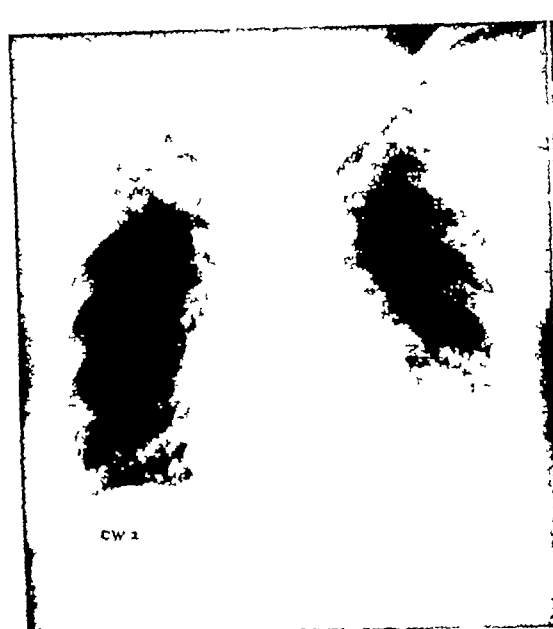


Fig 10 Case 4 At conclusion of the first treatment course

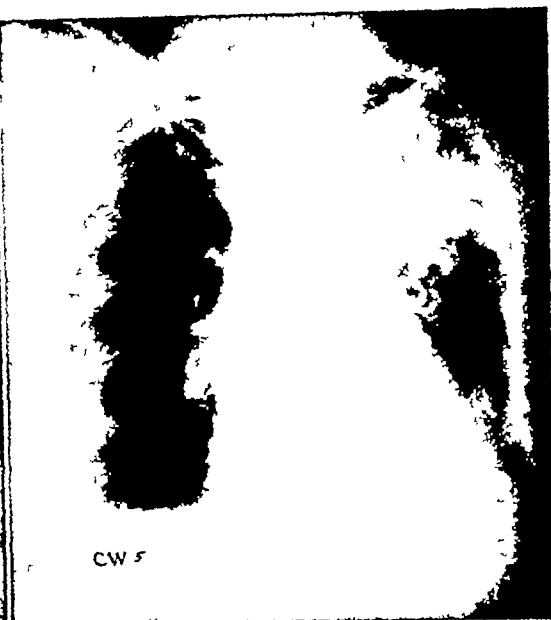


Fig 11 Case 4 Three months after the first cycle and at the conclusion of the second

Course 1 X—79 T E D
X'—85 T E D
Y—6 T E D
Z—44 T E D

Course 2 Average 1 to 15 T E D at points X, X', Y, Z

Total r 10,450 at first cycle (4 portals)

3,000 at second cycle (2 portals)

13,450 r in three months' period

A film made at the conclusion of the first cycle (Fig 10) shows both lungs clear. The patient stood the treatment well (Course 1), complaining only of moderate general fatigue toward the end. Her red and white blood count was not markedly depressed. Erythema began before the end of the treatment, superficial desquamation of the treated areas was complete after several weeks, and healing was accomplished in about forty days. The immediate post-treatment course was about the same as in Case 1, although more treatment was given. The reason for less treatment and proportionately more marked skin reaction in Case 1 was the fact that the treatment was given during a spell of intense summer heat,

whereas Case 4 was treated in more moderate weather.

Following the administration of over 10,000 r to the thorax, the patient experienced no chest pain, cough, fever, or other symptoms as far as could be learned. A film was made six weeks after the first cycle and showed slight increase of the peribronchial markings in the left lung and a little diffuse haziness in the lower axillary zone. About ten weeks after the first cycle the patient began to have moderate cough and productive morning sputum, and examination of the chest showed dullness, decreased breath sounds, and a few moist râles over the upper two-thirds of the left lung-field. As we were uncertain as to whether or not the findings in the chest were due to metastasis, and as the tumor masses, though rapidly regressing, still contained the possibility of active disease, it was decided to treat again, through two smaller portals, the residual masses. Figure 11 shows the chest three months after the first cycle and at the conclusion of the second.

Ten days later the patient contracted pneumonia following exposure, and died.

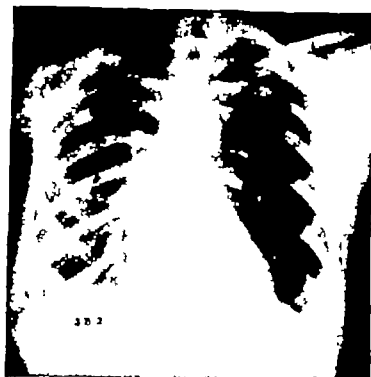


Fig 7 Case 2 Three months after treatment

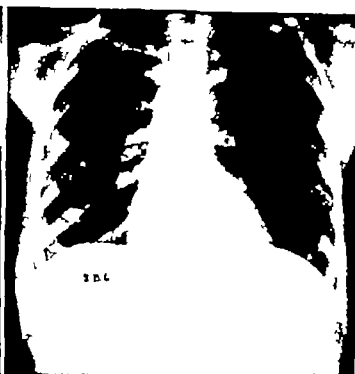


Fig 8 Case 2 Seven months after treatment

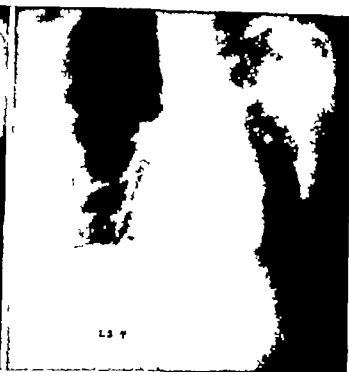


Fig 9 Case 3 Six months after the first cycle three months after second

weather, the patient contracted a moderate head cold, and with it, for the first time, suffered severe pleuritic pains in the right chest. A film made during the attack showed the right lung-field again hazy, though less so than at the three-month period illustrated in Figure 7. In Figure 8 the lungs are again entirely clear, although the patient now has far advanced melanotic metastases elsewhere.

Several writers have touched on the lowered resistance to injuries of irradiated lung. Wintz (10), in particular, speaks of the bad prognosis in the event of intercurrent disease. This aspect of the case might be considered illustrative of the effect of a mild respiratory infection on vulnerable lung and pleura, with, however, a good outcome as far as the local process was concerned.

Case 3 An unmarried woman, aged 66 years, with general arteriosclerosis, who had had at least one stroke, was referred for post-operative prophylactic radiation of the left chest following radical mastectomy for fibrocarcinoma with extensive axillary metastases.

She was given the conventional treatment in use in our laboratory for a number of years, of 750 to 800 r at a single dose, using five portals on the first cycle and three on a second, two and a half months later. She received at the first cycle 225 T E D at the point which I have designated X (see Fig 1). At the second cycle,

155 T E D at point X, other areas in proportion. I include only one film of her series.

Figure 9 shows the condition six months after the first cycle, three months after the second. Films at two-month intervals have shown moderate progressive clearing to the present time. The patient has felt well at all times: no cough, no other symptoms; the only sign, harsh breathing over the left upper lobe. Note calcification in the aorta.

Case 4 A woman, aged 68 years, with primary inoperable carcinoma of the left breast with axillary and supraclavicular metastases, the nature of whose tumor was confirmed by aspiration biopsy. She has been treated by roentgen irradiation alone, the details of which are as follows:

Course 1 Four portals, 200 r daily to each of two portals

Total per portal

2,660 r to supraclavicular portal

2,660 r to anterior breast

2,470 r to axilla direct

2,660 r to axilla posterior

Course 2 Three months later, fractional treatment through two "portals" directly over residual breast and axillary masses

Total 1,500 r per portal

Depth doses at designated points (see Fig 1)

With a distinct line of demarcation, the lower portion of the left lower lobe was completely consolidated, having a dark, reddish-gray surface and appearing to be lobar pneumonia in the stage of gray hepatization. The right lung showed more extensive pneumonic process, with complete consolidation of both upper and lower lobes. There was entire absence of the peculiar carnification found in the left lung. There was no evidence of metastases in either lung.

A photomicrograph (Fig 13) which was selected as typical of all the sections made of the left lung, except the base, shows intense thickening of the alveolar walls, with some exfoliation of the lining cells into the lumen. Perivascular and peribronchial thickening are evident in all sections. There was no evidence of cancer infiltration in any of the lung tissue.

DISCUSSION

Taking Cases 1 and 4, which received the most radiation, it would appear that conditions of extensive recurrence and of primary inoperable malignancy were greatly benefited by the heavy dosage employed. It seems highly probable that the price paid in lung damage will be exacted in a large proportion of any further cases so treated. Justification for this risk to the patient, both in primary morbidity or mortality, and in the hazard of intercurrent diseases on vulnerable radiated lung, must, I feel, be decided for each case on its merits. Case 1, obviously hopeless at the outset, has had a year of excellent health, with freedom from demonstrable disease, and no one knows what further expectation of life. Case 4, equally hopeless, showed marked improvement of her primary condition, with axillary and supraclavicular metastases completely dispersed, her breast tumor reduced from $6 \times 8 \times 3$ cm to 1.5 cm in diameter, and the small islands of viable cells walled off by fibrous tissue. The existence of viable cancer cells at all, after the heavy radiation received, constitutes the most discouraging

fact of radiation therapy. Critics might be of the opinion that, as long as I could not hope to cure her anyway, I might better have been satisfied with the amount of walling off by fibrous tissue which the first cycle would produce. But there was still a small axillary node remaining before the beginning of the second cycle, and none found when she died. It is very difficult to feel certain whether her right lung and left base pneumonia had anything to do with the traumatized left upper lobe.

It is interesting here to recall that Evans and Leucutia propound the following limits in respect to lung damage: "If a single dose exceeding 100 per cent SUD is delivered to lungs, infiltration may occur. If the dose is lower than 140 per cent SUD, the infiltration usually clears up, if it exceeds 140 per cent, fibrosis may develop."

Desjardins (3) states that he has observed some degree of pleuropulmonitis in 2.5 per cent of several hundred cases in which the thorax received from 800 to 1,000 r (measured in air), but has never seen a reaction after 600 r.

In such of my cases as received adequate film examination and clinical follow-ups, about twenty cases from the Strang Clinic and about forty more from the Woman's Hospital, in New York, I have found no other, receiving as little radiation as Case 3, that showed similar roentgen changes, or sufficient clinical signs or symptoms to attract notice.

Other apparent inconsistencies are brought to light in the two following cases, not included in my detailed description.

Case 5. A woman of 54, unusually vigorous and young looking for her age, having mammary carcinoma, was given about the same amount of treatment, in a single cycle, as Case 1. She showed moderate increase peribronchial markings at the right base only, faintly perceptible in film two months after treatment, reaching a maximum at four months, and completely disappearing by the eighth month.

Case 6. A patient 47 years old received moderate roentgen treatment for mam-



Fig 12 Case 4 Vertical cross-section of the left lung. Note consolidated pneumonic area sharply demarcated at base typical radiation changes above



Fig 13 Case 4 Intense thickening of alveolar walls with exfoliation of lining cells into the lumen, perivascular and peribronchial thickening. No evidence of carcinoma

shortly afterward. A portable supine film taken two days before her death showed consolidation of the lower half of the right lung, infiltration of the left base, plus the findings previously shown in the upper left lung-field. The question of whether or not her death was due to infection arising first in the vulnerable radiated area and spreading elsewhere cannot be positively decided. The history of severe exposure was authentic, however, and postmortem findings showed practically no pneumonia in the radiated areas and frank consolidation elsewhere.

Figure 12 shows the gross specimen of the left lung in vertical cross-section.

Postmortem examination showed the breast tumor, measuring 1.5 cm in diameter. No nodes were palpable in the axilla or supraclavicular area. Microscopic examination disclosed an extremely

cellular duct cell carcinoma. There were obvious regressive changes in the tumor, each island of cancer cells being completely circumscribed by a wall of fibrous tissue.

Both lungs were bound to the chest wall and diaphragm by soft, easily broken adhesions. The left apex was found to be densely adherent by old fibrous bands. The left lung, after removal, was seen to be covered for the most part with a sticky, yellowish-green, fibrinopurulent exudate. Cross-section of this lung revealed a firm, consolidated surface. The pleura was definitely thickened and the interlobar pleura was a dense, fibrous band. The entire upper lobe and upper half of the lower lobe were involved in a peculiar consolidation consisting of dense, patchy, dull white areas, many of which seemed to be in close relation to the smaller bronchi. There was definite peribronchial fibrosis throughout

SOME OF THE DIFFICULTIES IN THE INTERPRETATION OF CHOLECYSTOGRAMS¹

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HERE have been many discussions of the efficiency and value of cholecystography, with records of the percentage of errors in the x-ray diagnosis of gall-bladder disease when checked by the operative findings. These articles have led us to a study of 520 cases operated upon, out of more than 5,000 cholecystograms done since June, 1925. All of these cases are from the x-ray departments of Rush Medical College and the Presbyterian Hospital of Chicago, both of which have the same personnel.

The careful checking of the x-ray and operative findings, with re-reading of films and looking for pitfalls in their interpretation, showed us that many errors can be avoided. We found that the most common causes of error, in their order of importance, were due to the following:

- 1 Gas in the bowel
- 2 Fecal or other opaque material in bowel
- 3 Technically poor films
- 4 Failure to recognize certain film shadows such as
 - (a) Kidney over liver simulating gall bladder,
 - (b) Loop of bowel mistaken for gall bladder,
 - (c) Gall bladder hidden by bone shadows
- 5 Errors in judgment such as the following
 - (a) Slight variations from normal,
 - (b) Borderline cases not checking with operation
- 6 Normals—found to be pathologic at operation

The lessons we learned from this study are herewith presented. Our cholecystographic procedure is as follows. The dye is given either orally or intravenously ac-

cording to the desire and judgment of the attending physician who also administers it. If given orally, the patient drinks the dye, dissolved in grape juice, at the close of the evening meal. If given intravenously, the dye is injected at 9:00 P.M. Food is then withheld, although water is permitted, and the patient is taken to the roentgen department at nine the next morning. Routinely, films are taken at nine and twelve o'clock, to show, respectively, the filling and concentration of the dye in the gall bladder. A meal of high fat content is then given and another film taken at two o'clock to show the emptying and contraction of the gall bladder.

Variations from the cholecystographic routine are made as follows:

If the dye was given orally, and the gall bladder fills faintly, or not at all, by twelve o'clock, the high fat meal is postponed until after the two o'clock film, and a subsequent film taken at four o'clock to show the possible gall bladder emptying. With the intravenous dye, failure of the gall bladder to fill by twelve o'clock, does not delay the routine procedure.

With both the oral and intravenous dye, failure to empty satisfactorily on the two o'clock film, necessitates another film at four o'clock, to determine the delay in emptying.

If gas or fecal material in the bowel interferes with the visualization of the gall bladder, one or two enemas usually help to clear the gall-bladder field, or at least shift the bowel content and change its position or configuration with reference to the gall bladder, thus differentiating it from a gallstone. Drinking water will usually move the gas in the upper small bowel.

It is very important that the films be of good technical quality. Wet films are examined in order to make any needed change in the routine. After the ex-

¹ Read before the Fourth International Congress of Radiology, July 24-31, 1934, at Zürich and St. Moritz, Switzerland.

mary carcinoma, preceded by heavy radium needling. Two years later she showed dense board-like fibrosis of her pectoral muscle, with the lung beneath entirely clear.

One correlation suggests itself from my material—that of age. While I agree with Desjardins, Groover, Christie, Merritt, and Coe, and others that the effect is a quantitative one, I think the possible influence of age and arteriosclerosis should be scrutinized here and in all subsequent reported cases. Case 1 was 63 years old, Case 3 was 66, Case 4 was 68. Two other of my cases, (7 and 8), receiving heavy thoracic radiation for inoperable malignancies with resulting pleuropulmonitis, not described here because they were complicated by metastasis, were 67 and 78, respectively. All five had advanced arteriosclerosis. Case 2, 28 years old, had a pleuritis of about two months' duration with complete resolution. Case 5, aged 54, showed slight changes, chiefly peribronchial thickening, of six months' duration, or from the second to the eighth month after treatment, with complete restoration. Case 6, with enough radiation to produce excessive soft tissue changes, showed no lung changes whatever. All of these cases were under 60 years of age, and were free of demonstrable arteriosclerosis. Reports in the literature do not consistently note ages of patients, though Davis gives the ages of two out of three of his patients as 44 each. I have not, of course, enough cases, either old or young, that have received intensive protracted fractional treatment to warrant making a definite statement, because such

treatment is necessarily reserved for a selected group of recurrent or inoperable cases, but the point seems interesting and worthy of further observation.

SUMMARY

1 A group of four cases showing varying degrees of pleuropulmonitis from thoracic radiation is described, together with accurate depth dose estimations.

2 Four other cases bearing on the subject are discussed briefly.

3 The possible influence of age and arteriosclerosis on the abnormal lung and pleural changes is suggested.

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Gas in the bowel was responsible for these errors. We feel that it is a serious error to report stones which are not actually present, while the reverse error is permissible.

Of interest in this group were 25 patients whose gall bladders filled and concentrated fairly well, and yet did not empty, or, if so, very slowly. A definite chronic cholecystitis was found in 24, 12 with stones. One patient, with no evidence of a primary emptying in spite of sufficient amount of the fat meal, and with considerable dye remaining in the gall bladder until the next day, showed at operation only a very slight cholecystitis with no stones.

It is important to remember that, before the diagnosis of a pathologic delay in emptying can be made, it must be established that the patient took and retained a sufficient amount of the high fat meal, was not unduly nauseated, and that a primary emptying of the gall bladder with a reabsorption of the dye did not occur. In this group of 145 cases the x-ray diagnosis was erroneous in 1.4 per cent.

In the third group of cases, the x-ray report of a normally functioning gall bladder with or without stones has the highest percentage of error when checked by operation. This report was made in 122 cases.

In the 32 cases diagnosed as normally functioning with stones, the operation revealed stones in 27. It seems quite certain that the five mistakes (15.6 per cent) were caused by gas in the bowel, in all of which the x-ray report stated that the stones were more or less questionable. From this experience it would seem better not to diagnose stones in a normally functioning gall bladder unless reasonably obvious.

The largest number of errors in Group 3 was made in 90 cases diagnosed as a normally functioning gall bladder without stones. In these cases the operation was done for suspected gall-bladder trouble on the basis of the clinical evidence and in spite of the normal x-ray reports. Of the 90 cases reported as normal by x-ray, the

operation revealed a normal gall bladder in 29, and a chronic cholecystitis in 61, 11 with stones.

On re-reading the films after operation, and with our increased knowledge, sufficient changes were noted to place 18 of these cases in Group 2. In that way our percentage of error in Group 3 would be reduced from 54 per cent to 39 per cent and our error in Group 2 changed from 1.4 per cent to 1.2 per cent. Furthermore it is well known that even a moderately severe cholecystitis need not interfere with normal function of the gall bladder, and also, that most surgeons and pathologists report as a chronic cholecystitis all cases in which any change from normal is found.

If the diagnosis of gall-bladder disease is left to the roentgenologist, he wants not only to do a cholecystogram but also a stomach and bowel examination for associated findings which may be elicited, such as compression, deviation of position, or change in function of these organs, or their relationship to a point of tenderness on pressure. In doubtful cases this often helps to swing the diagnosis one way or the other. Sometimes an x-ray study of the urinary tract is also needed.

The reports of 21 American authors who give statistical data concerning their series of cholecystograms, particularly those checked by operation, record a total of 39,280 cases, from which number 5,983 were operated upon. An average of the figures given in these reports indicates that the x-ray diagnosis of a pathologic gall bladder was confirmed at operation in 93.3 per cent, while the x-ray diagnosis of a normal gall bladder was confirmed in only 76.3 per cent.

In the series of 520 cases operated upon, herewith reported, the original x-ray report of a pathologic gall bladder was confirmed in 93.7 per cent, and after restudy and elimination of avoidable errors, in 97.5 per cent. The original x-ray report of a normal gall bladder was confirmed in 32.3 per cent, and after restudy and elimination of avoidable errors, was confirmed

amination is completed and the films are dry, the final report is made. As far as results are concerned in both the oral and intravenous methods, I refer to my paper in which I reviewed 1,616 hospital case records, checking as far as possible the clinical and operative findings as compared with the x-ray report of the cholecystogram. There was a surprisingly close agreement between the two methods. As a result of this study, and in view of our subsequent experience, we feel that it is perfectly fair first to give the dye orally, since this is the more simple procedure. Then, if not entirely satisfactory, the examination may be rechecked by the intravenous method. In our experience this is seldom necessary.

We have accepted the customary classification in the diagnosis of cholecystograms and divide the x-ray findings into three groups, as follows:

Group 1 Non-functioning, with or without stones

Group 2 Poorly functioning, with or without stones

Group 3 Normally functioning, with or without stones

The first five of these diagnoses are indicative of a pathologic gall bladder, and the last is an x-ray normal. In the first group of cases the x-ray report of no filling, either with or without stones, is almost certain evidence of a pathologic gall bladder. In a total of 248 cases so reported, the operation revealed stones in the gall bladder or ducts in 200, and a chronic cholecystitis without stones in 33.

Errors in the report of a non-functioning gall bladder occurred in 15 cases, as follows:

In ten patients, whose x-ray films showed no evidence of gall-bladder function, the pathology found at operation was located outside the gall bladder. In eight patients there was a carcinoma of the head of the pancreas, in one a chronic pancreatitis, and in one a tuberculous peritonitis with adhesions to the duct.

Three cases that showed a chronic cholecystitis at operation, were considered

normal on review, once because of gas and an over-penetrated film, and twice because the gall bladder was hidden by bone shadows. In one large patient whose gall bladder had been previously removed a loop of bowel was mistaken for a faintly functioning gall bladder. One case that was normal at operation was called non-functioning by x-ray, probably because the capsules for the dye, used in our early work, did not dissolve well enough.

Five cases, originally reported as belonging in Groups 2 and 3, would, with our increased knowledge, have been put into this first group of non-functioning gall bladders. At operation, all five showed a chronic cholecystitis with stones.

Our errors were due to the fact that the overlapping shadows of the liver and kidney had been mistaken for a gall bladder. On review it was evident that these shadows had overlapped a little more or less on the various films, due to a shift in position of the patient, and thus had simulated a functioning gall bladder. This error can be avoided only by constantly bearing in mind that the lower end of the kidney-liver shadow is pointed instead of rounded as is the gall-bladder shadow. In this total group of 253 cases, the original x-ray report was erroneous in 7.9 per cent, and after the correction of avoidable errors, was erroneous in 3.9 per cent.

The second group of cases, the x-ray report of which is a poorly functioning gall bladder with or without stones, comprises those in which there is some evidence of function, although less than normal. These are the cases which fill or empty slowly, do not concentrate the dye, are unusually large or small, have some definite deformity of contour, or perhaps are only slightly less dense than normal. All of the 145 cases reported as belonging in this group showed pathology of the gall bladder at operation, stones in the gall bladder or ducts in 127, and chronic cholecystitis in 18. In 15 cases, stones were found which were not reported prior to operation, and in two cases stones which were diagnosed by the x-ray were not found at operation.

SYMPOSIUM ON RIGHT UPPER ABDOMINAL PAIN¹

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Reported by L J CARTER, M D

DR BALFOUR stated that pain in the right upper quadrant might be due to lesions in various locations, viz , in the right upper quadrant, elsewhere in the abdomen, in the chest, and to general disease. The most frequent conditions in the right upper quadrant causing pain are lesions in the gall bladder and the duodenum. The more severe the symptoms attributable to these conditions, the greater relief is obtained from surgery. On the other hand, the less severe the symptoms, the less likely is relief to be obtained from surgery. Among the diseases occurring elsewhere in the abdomen the ones most likely to produce pain in the right upper quadrant are those associated with the appendix. The diseases within the chest with which pain in the right upper quadrant is most frequently associated are coronary thrombosis, pneumonia, and pleurisy, especially of the diaphragmatic type. Among general diseases most frequently associated with pain in the right upper quadrant are tabes and herpes zoster.

Discussing the treatment of duodenal ulcer, Dr Balfour showed a series of lantern slides illustrating the various operations for duodenal ulcer.

Dr Kirklin showed a very fine series of lantern slides, illustrating duodenal and gall-bladder diseases, these being the chief conditions in the right upper quadrant which are demonstrable radiologically. He stated that the radiologist should recognize lesions of the duodenum in 100 per cent of the cases, although he might not be able to identify the lesion in all the

cases. Duodenal ulcer is recognizable radiologically in 95 per cent of the cases, the fluoroscope being of prime importance in the diagnosis. In acute perforations of the gastro-intestinal tract a diagnostic sign is the presence of gas above the liver and underneath the diaphragm. Acute duodenitis gives characteristic findings, namely, a reticular network of barium in the duodenum, irritability of the first and second parts of the duodenum, and absence of the characteristic crater of an ulcer. A number of characteristic slides of diverticulum of the duodenum were shown. Hypertrophy of the pyloric muscle was shown in a number of slides. The characteristic appearance was an elongated, slightly irregular area of barium connecting the pyloric end of the stomach and the duodenal cap. It is narrow and definitely distinguishable from ulcer and carcinoma.

A very complete analysis was given by Dr Kirklin of his work in cholecystography, in which he uses the oral method. Lantern slides showed the following findings: normal concentration of the dye, irregularities in size of the gall bladder, deficiency in concentration of the dye, gallstones accentuated by the dye, and papilloma and adenoma. In Dr Kirklin's hands this method is correct in 97.1 per cent in showing poorly functioning gall bladder, is correct in 96.8 per cent in showing non-functioning gall bladder, and is correct in 89.5 per cent in demonstrating normal gall bladder. The diagnosis of gallstones has been greatly improved by the dye method. In the radiographic work the greatest care must be taken to have the technic perfect. Examples were

¹ The above theme was the subject of a symposium given at the Annual Meeting of the Manitoba Medical Association, in Winnipeg, Sept. 10, 1934.

in 52.3 per cent of the cases operated upon for suspected gall-bladder disease

SUMMARY

1 Technically correct films are important

(a) Watch wet films and be sure that the gall-bladder region is centered on the film and not hidden under bone shadows

(b) If the gall bladder is not visible on the first film, turn the patient and take another film

(c) If the patient vomited the dye, take one trial film and if no gall-bladder shadow is present, repeat the whole procedure

2 Our greatest source of error was due to gas or fecal material in the bowel

(a) The giving of enemas or the drinking of water by the patient, helped most to change the size or position of these shadows, and thus aided in film interpretation

(b) Shadows which simulate gall bladder must be evaluated

3 Positive findings, either of function or stones, are seldom missed in the x-ray examination

(a) Of interest is a group of non-functioning gall bladders associated with carcinoma of the head of the pancreas

4 Indefinite findings are more difficult of interpretation, and call for experience and good judgment on the part of the roentgenologist. In some cases the findings may be questionable as to pathology, not only for the roentgenologist, but for the surgeon and pathologist as well

5 It is just as important for the radiologist to stand on a diagnosis of normal, as to try to bolster the clinician's diagnosis of a pathologic gall bladder on insufficient x-ray evidence

6 Only by the closest co-operation between the roentgenologist and the clinician or surgeon, can the highest percentage of correct diagnoses be made and the welfare of the patient best be served

for the detection of the cause of right upper abdominal pain mentioned by Dr Carter were the Graham functional liver test, an adaptation of the iodeikon test, the use of the intravenous method of pyelography, which is preferable to the retrograde method in suspected right hydronephrosis,

and his condemnation of the use of thoro-trast intravenously as a dangerous method. The barium meal should not be given if acute intestinal obstruction is suspected, or if acute perforation of the stomach or small bowel, or partial obstruction of the large bowel exists.

shown of gallstones missed by poor focussing or by movement of the patient, and these same stones shown when the faults of technic were corrected. Particularly striking was Dr Kirklin's demonstration of papilloma of the gall bladder, and its differentiation from gallstones and adenoma.

Dr Hunter emphasized lesions of the abdominal wall as causes of pain. The injection of novocain, 0.5 per cent, relieves the pain. He showed the changed point of view of the surgeon in recognizing that peptic ulcer is largely a medical disease, and not a surgical one primarily, and that surgery should be reserved for such complications as obstruction, perforation, and recurring hemorrhage. Similarly the trend of treatment in gall-bladder disease is away from surgery and toward medical methods. Surgery should be reserved for empyema of the gall bladder, uncontrollable attacks of biliary colic, and the persistence of digestive disturbances in spite of medical treatment. Dr Hunter emphasized the importance of treating the patient, as well as the disease, in peptic ulcer and gall-bladder disease.

Dr Brandson stated that we should approach the study of pain in the right upper quadrant through our knowledge of anatomy, particularly of nerve distribution. For instance, the reason for the reference of kidney pain to the external genitals is the fact of their common origin in the same fetal tissue. We also should remember the segmental nerve supply. He called attention to the classic statement of Hilton that the nerve supply of the skin and the underlying organs is from the same nerve segment. One should also remember the position of the sympathetic nerve ganglia as explaining pain radiation, as an example, shoulder pain in right upper abdominal inflammations.

Dr Carter, in expressing appreciation of the visit of Dr Kirklin, emphasized the original contributions of Dr Kirklin, namely, in the diagnosis of pyloric hypertrophy, acute duodenitis, and papilloma of the gall bladder.

Dr Carter reviewed a number of his own cases which had come to operation for the relief of right upper abdominal pain, and showed that 40 per cent were due to chronic cholecystitis, 14 per cent to adhesions and bands, 9 per cent to duodenal ulcer, 4 per cent to carcinoma of the stomach, 1 per cent each to several other more rare conditions, while 15 per cent showed no demonstrable lesion in the right upper quadrant. In this 15 per cent the lesion was found in the lower right quadrant and was associated with ileocecal pathology. Also, in this 15 per cent the gall-bladder tenderness and the duodenal deformity demonstrated in the right upper quadrant were reflex spastic phenomena, the sure precursors of later pathology.

In the matter of duodenal bands and adhesions, occurring in 14 per cent of the cases, the radiologic indications were deformity of the duodenal cap, with regular lines as distinct from the deformity of ulcer, angulation of the second part of the duodenum upward or outward, and dilated second portion of the duodenum. That the careful removal of these constricting bands and adhesions from the duodenum does give relief of symptoms, was shown in 40 cases operated upon, in which relief was obtained from the symptoms in from 50 to 80 per cent.

Dr Carter instanced his own experience with cholecystography. He had administered the dye, iodeikon, in nearly a thousand cases, using the oral method. In a series of cases that came to operation, the test was found correct in 95 per cent, in which it indicated gall-bladder pathology. As a test of the absence of gall-bladder disease it was of less value—a diseased gall bladder may be capable of functioning normally. The method has its greatest value as a test of gall-bladder function. A gall bladder, however diseased, if it is functioning normally, according to this test, should not be removed, but should be given a chance of recovery under medical treatment.

Among the methods of examination

penile carcinomas were pathologically reported to be papillary and 87 infiltrating. Microscopically, the carcinoma is almost always a squamous-cell epithelioma, this was true in our series except for two lesions, one of which was a hemangiosarcoma and the other a melano-epithelioma. Sixty-four (or 32.82 per cent) of the carcinomas in the series were not graded according to

Broders' classification. Of the 131 carcinomas that were graded, 18 (or 13.74 per cent) were of Grade 1, 60 (or 45.80 per cent) of Grade 2, 40 (or 30.53 per cent) of Grade 3, and 13 (or 9.92 per cent) were of Grade 4. Thus of the lesions that were graded, those of lower grades slightly predominated, 60 per cent were graded 1 or 2, and 40 per cent were graded 3 or 4 (Table II).

TABLE I—CLASSIFICATION ACCORDING TO GROUP

Group	Total	Per cent	Died	Living at last report	Living now	Not traced	Subsequent life in years						Surgery here	Radium here	X-ray here
							1 to 5	5 to 10	10 to 15	15 to 20	20 to 25	Not stated			
I	41	21.02	14	13	10	4	13	14	5	3	1	1	36	8	14
II	36	18.46	19	6	9	2	21	5	4	1	2	1	20	6	14
III	32	16.41	17	5	9	1	21	8	8	2	2		28	7	9
IV	86	44.10	56	13	6	11	54	11	7	1	2	2	41	26	24
Total	195	100	106	37	34	18	109	38	16	5	5	4	125	47	61

TABLE II—CLASSIFICATION ACCORDING TO GRADE OF MALIGNANCY

Grade	Total	Per cent	Group				Died	Living at last report	Living now	Not traced	Subsequent life in years					
											I	II	III	IV	1 to 5	5 to 10
1	18	9 23	6	3	3	2	2	3	6	3	6	2	2			
2	60	30 77	12	5	13	20	27	13	8	1	32	5	6	2	3	1
3	40	20 51	8	8	7	14	18	9	10		23	9	4	1		1
4	13	6 67	1	3	1	4	7	1	1		6	2	1			
Not graded	64	32 82	14	17	8	46	52	11	9	14	42	20	3	2	1	3
Total	195	100 00	41	36	32	86	106	37	34	18	109	38	16	5	5	4

TABLE III—CAUSE OF DEATH (106 PATIENTS)

	Total	Per cent	Grade										Group							
			1		2		3		4		Not graded		I		II		III		IV	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Died of carcinoma	77	72.64	1	1	20	26	15	19	5	6	36	47	6	8	15	19	10	13	46	60
Died from other causes*	15	14.15			5	33	1	6	2	13	7	46	5	33	1	6	5	33	4	27
Cause not stated	14	13.20	1	7	2	14	2	14			9	64	3	21	3	21	2	14	6	43
Total	106	59.89																		

* Four of these fifteen patients died of apoplexy, four of bronchopneumonia, two of "old age," and one each of influenza, influenza and heart trouble, heart trouble, cerebral hemorrhage, and nephritis and dropsy, and diabetic coma.

RESULTS OF TREATMENT OF CARCINOMA OF THE PENIS¹

By HARRY H BOWING, M D, ROBERT E FRICKE, M D, Section on Therapeutic Radiology, and VIRGIL S COUNSELLER, M D, Division of Surgery, Mayo Clinic, Rochester, Minnesota

CARCINOMA of the penis is sufficiently rare to be of considerable interest with regard to its manifestations, mode of growth, and treatment. A survey of the literature on the subject in the past decade reveals an abundance of reports describing one or two cases. There are also excellent detailed studies of a larger series of cases contributed by Barringer and Dean (1), Dean (3, 4), Colby and Smith (2), Lewis (6), Pfahler and Widmann (7), Schreiner (8), Schreiner and Kress (9), and Howze (5). Many authorities report an incidence of from 1 to 3 per cent of penile carcinomas among all carcinomas in the male. During 1931, 3,505 patients with carcinoma were seen at The Mayo Clinic, 1,992 of these were men. Of these 1,992 men, six (or 0.301 per cent) had carcinoma of the penis. A total of 204 men in this series had carcinoma of the genito-urinary organs, and the six with penile carcinoma hence form 2.94 per cent of this group. Although this of course represents only the incidence for one year, it is probably a fair sample of the incidence of this disease.

The incidence of the disease is usually higher among those in the sixth decade of life. Of 195 patients with carcinoma of the penis seen at The Mayo Clinic from 1907 to 1932, 63 (or 32.3 per cent) were between fifty and sixty years of age. Of the remaining patients in this series, seven were in the third decade, 19 in the fourth, 43 in the fifth, 35 in the seventh, 23 in the eighth, and five in the ninth.

The etiologic factors in penile carcinoma are rather uniformly described as phimosis, balanitis, leukoplakia, syphilis, and

trauma. Practically no cases of the disease occur among men who were circumcised in infancy. The Jewish race is almost immune. In the series of 195 cases, phimosis was noted in 87, balanitis in seven, and leukoplakia in one. Wassermann tests were not performed in 62 cases, in the remaining 133 cases only two reactions were positive. A history of syphilis was obtained in nine cases and of gonorrhea in 43. Circumcision in adult life may possibly predispose to carcinoma of the penis, and yet it may be performed because of the irritation of an existent unrecognized lesion, the operation uncovering the growth. In our series, 68 patients (or 34.87 per cent) had recently been circumcised. Not one of our patients had been circumcised in infancy.

To facilitate the study of treatment and of results we have divided all of our cases into four groups according to the extent of the primary lesion and the presence or absence of metastasis. A small lesion of less than 2.5 cm in diameter, without metastasis, we have designated as belonging to Group I. A similar small lesion with metastasis to the inguinal nodes belonged to Group II. Group III included large lesions more than 2.5 cm in diameter without evident metastasis to lymph nodes, and Group IV included large lesions with metastasis to the inguinal nodes or elsewhere (Table I).

A careful classification of any type of carcinoma is necessary to study its characteristics and the best methods of treatment. Considering gross pathology, carcinoma of the penis occurs in two forms: the papillary (usually on the glans) and the infiltrating (usually in the prepuce). The former is usually regarded as the more common. In our series, 108 of the

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Broders' classification. Of the 131 carcinomas that were graded, 18 (or 13.74 per cent) were of Grade 1, 60 (or 45.80 per cent) of Grade 2, 40 (or 30.53 per cent) of Grade 3, and 13 (or 9.92 per cent) were of Grade 4. Thus of the lesions that were graded, those of lower grades slightly predominated, 60 per cent were graded 1 or 2, and 40 per cent were graded 3 or 4 (Table II).

TABLE I—CLASSIFICATION ACCORDING TO GROUP

Group	Total	Per cent	Died	Living at last report	Living now	Not traced	Subsequent life in years						Surgery here	Radium here	X-ray here
							1 to 5	5 to 10	10 to 15	15 to 20	20 to 25	Not stated			
I	41	21.02	14	13	10	4	13	14	5	3	1	1	36	8	14
II	36	18.46	19	6	9	2	21	5	4	1	2	1	20	6	14
III	32	16.41	17	5	9	1	21	8	8	1	2	2	28	7	9
IV	86	44.10	56	13	6	11	54	11	7	1	2	2	41	26	24
Total	195	100	106	37	34	18	109	38	16	5	5	4	125	47	61

TABLE II—CLASSIFICATION ACCORDING TO GRADE OF MALIGNANCY

Grade	Total	Per cent	Group				Died	Living at last report	Living now	Not traced	Subsequent life in years					
											1 to 5	5 to 10	10 to 15	15 to 20	20 to 25	Not stated
			I	II	III	IV										
1	18	9 23	6	3	3	2	2	3	6	3	6	2	2	1		
2	60	30 77	12	5	13	20	27	13	8	1	32	5	6	2	1	
3	40	20 51	8	8	7	14	18	9	10		23	9	4	1		
4	13	6 67	1	3	1	4	7	1	1		6	2	1			
Not graded	64	32 82	14	17	8	46	52	11	9	14	42	20	3	2	3	
Total	195	100 00	41	36	32	86	106	37	34	18	109	38	16	5	4	

TABLE III—CAUSE OF DEATH (106 PATIENTS)

	Total	Per cent	Grade										Group							
			1		2		3		4		Not graded		I		II		III		IV	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Died of carcinoma	77	72.64	1	1	20	26	15	19	5	6	36	47	6	8	15	19	10	13	46	60
Died from other causes*	15	14.15			5	33	1	6	2	13	7	46	5	33	1	6	5	33	4	27
Cause not stated	14	13.20	1	7	2	14	2	14			9	64	3	21	3	21	2	14	6	43
Total	106	59.89																		

* Four of these fifteen patients died of apoplexy, four of bronchopneumonia, two of "old age," and one each of influenza, influenza and heart trouble, heart trouble, cerebral hemorrhage and nephritis and dropsy and diabetic coma.

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			I	II	III	IV										
1	18	9 23	6	3	3	2	2	3	6	3	6	2				
2	60	30 77	12	5	13	20	27	13	8	1	32	5	6			
3	40	20 51	8	8	7	14	18	9	10		23	9	4	1		
4	13	6 67	1	3	1	4	7	1	1		6	2	1			
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			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Died of carcinoma	77	72.64	1	1	20	20	15	19	5	6	36	47	6	8	15	19	10	13	46	60
Died from other causes*	15	14.15			5	33	1	6	2	13	7	46	5	33	1	6	5	33	4	27
Cause not stated	14	13.20	1	7	2	14	2	14			9	64	3	21	3	21	2	14	6	43
Total	106	59.89																		

* Four of these fifteen patients died of apoplexy, four of bronchopneumonia, two of "old age," and one each of influenza, influenza and heart trouble, heart trouble, cerebral hemorrhage and nephritis and dropsy, and diabetic coma.

Penile carcinomas are, as a rule, very slow growing. In 27 of our cases, symptoms had been present for more than five years. Apparently the growth also metastasizes late. The site of metastasis is determined by lymph drainage. The superficial lymph vessels of the penis drain into the inguinal nodes. The deeper tissues are drained by lymph vessels accompanying the dorsal vein into nodes in the pelvis. As penile epitheliomas remain superficial for a long time, metastasis in most cases is to the nodes of the groin. Logically, the mode of treatment and the results vary with the extent of the disease, so we will consider treatment and results for each separate group.

In Group I (small lesions without evident metastasis) are listed 41 cases, in ten of which operation was performed elsewhere, such operation consisted of excision of the growth in seven cases, dorsal-slit operation in five, biopsy in three, and cautery in ten. Five of these patients had had radium treatment elsewhere. In 36 of the cases operation was performed at the Clinic and consisted of biopsy in four cases, circumcision and excision in two, excision of the growth in six, amputation of the penis in eight, partial amputation in five, radical amputation and dissection of the inguinal nodes in one, emasculation in one, amputation and bilateral dissection of the nodes in thirteen, and dissection of the nodes in two. In eight cases radium was applied to the penile growth at the Clinic, in four of these, it was applied post-operatively. In six cases it was applied to the inguinal nodes post-operatively. Low voltage roentgen-ray treatment was applied to the penile growth in five cases, and the same treatment was used over the inguinal nodes in thirteen. Ten patients in this group replied to letters sent them six months prior to the writing of this paper, 13 could not be traced at this time, but were living at the time of a previous inquiry, four could not be traced at this time nor at the time of the previous inquiry, and 14 were definitely known to have

died. When last heard from, 13 of the patients in this group had lived from one to five years, 14, from five to ten years, five, from ten to 15 years, three, from 15 to 20 years, and one, from 20 to 25 years.

Group II (small lesions with metastasis) contains 36 cases, in 17 of which surgical procedures were performed elsewhere. Twenty patients underwent operation at the Clinic, which consisted of biopsy in three cases, circumcision and excision in one, excision in three, simple amputation of the penis in seven, amputation with dissection of the nodes in six, partial amputation without dissection of nodes in one, and partial amputation with dissection of the nodes in three. A dorsal-slit operation was performed in one case and removal of inguinal nodes in four cases. Radium treatment was given in six cases, in three of these to the primary lesion and in three to the inguinal nodes. Roentgen-ray treatment was applied in 14 cases. Nine patients in this group replied to letters sent them six months prior to the writing of this paper, six could not be traced at this time but were living at the time of a previous inquiry, two could not be traced at this time nor at the time of the previous inquiry, and 19 were definitely known to have died. When last heard from, 21 of the patients in this group had lived from one to five years, five, from five to ten years, four, from ten to 15 years, one, from 15 to 20 years, and two, from 20 to 25 years.

Group III (large lesions without metastasis) contains 32 cases, in seven of which some form of operation had been performed elsewhere. Surgery was performed at the Clinic in 28 cases and consisted of biopsy in two, circumcision and excision in one, simple excision in four, amputation of the penis in seven, amputation with dissection of the nodes in eleven, partial amputation with dissection of the nodes in one, radical amputation in four, dorsal-slit operation in one, plastic operation in three, and removal of all inguinal nodes in two. Radium treatment was applied in seven cases to the primary lesion

and in five to the inguinal nodes as well, roentgen-ray treatment was given to nine patients (in two of these cases to the primary lesion). Nine patients in this group replied to letters sent them six months prior to the writing of this paper, five could not be traced at this time but were living at the time of a previous inquiry, one could not be traced at this time nor at the time of the previous inquiry, and 17 were definitely known to have died. When last heard from 21 of the patients in this group had lived from one to five years, eight, from five to ten years, and two, from 20 to 25 years.

Group IV (large lesions with metastasis) contains by far the largest number of cases, 86, or 44.10 per cent of the total. In 38 of these cases some form of operation had been performed elsewhere. In 41 cases operation was performed at the Clinic and consisted of biopsy in six, circumcision and excision in one, simple excision in one, simple amputation in 18, amputation with removal of the nodes in eleven, partial amputation in one, partial amputation with removal of the nodes in two, radical amputation in two, emasculation in three, plastic operation in two, and dissection of inguinal nodes in seven. Twenty-six patients had radium treatment, 17 to the primary lesion and 26 to the inguinal nodes. Twenty-four had roentgen-ray treatments, four to the primary lesion, and the remainder to the groins. Six patients in this group replied to letters sent them six months prior to the writing of this paper. 13 could not be traced at this time but were living at the time of a previous inquiry, 11 could not be traced at this time nor at the time of previous inquiry, and 56 were known to have died. When last heard from, 54 had lived from one to five years, eleven, from five to ten years, seven, from ten to 15 years, and one, from 15 to 20 years.

Considering the entire four groups, and leaving out the 18 patients who were not traced, 34 patients (19 per cent) have replied to letters sent them, 37 (21 per cent) could not now be traced but were living at the time of a previous inquiry,

and 106 (60 per cent) were definitely known to have died (Table III). When we consider that this study began in 1907, that these patients are in the cancer age, that their life expectancy is low, and that seven of them had other co-existing malignant conditions (three had carcinoma of the lip, two of the face, one of the bladder, and one of the rectosigmoid), the high death rate is to be expected. Of the 106 patients who were known to have died, 77 died of carcinoma, 15 died of causes unrelated to the carcinoma, and for the remaining 14 the cause of death was not stated.

The results of treatment according to the grade of malignancy comply with our expectations. Considering only the cases in which the patients were traced and the lesions graded, six of the patients with lesions of Grade 1 are known to be living and two are known to have died, eight of those with lesions of Grade 2 are living and 27 are known to have died, ten of those with lesions of Grade 3 are living and eighteen are known to have died, and one with a lesion of Grade 4 is known to be living and seven are known to have died. Of those with ungraded lesions, nine are living and 52 have died.

The preponderance of cases in this report in which some surgical procedure was employed is due in large measure to the fact that this review begins in 1907 and radium did not come into use at the Clinic until about 1915. Of late years, irradiation has been the usual practice, together with whatever surgical intervention is indicated. In what follows, the patients whom we list as now living have all been traced within the past six months, and we have definite information about those patients listed as having died. However, there is a large number of patients who have not been traced up to the present time. Many patients have lived five or ten years since treatment, and were perfectly well at the time when last heard from (Table IV). Considering our entire 195 patients, 62 (or 31.79 per cent) were treated by surgery alone. Eleven of these patients are still living, 34 have died. The next largest

group received both surgical treatment and irradiation with roentgen rays, there were 37 patients in this group, or 18.97 per cent of the total. Eleven of this group are known to be living and eleven are known to be dead. The next largest group, consisting of 15 patients or 7.69 per cent of the total, received surgical treatment and irradiation with both radium and roentgen rays. Two of these patients are known to be living and ten are known to be dead. Thirteen patients (or 6.66 per cent) received surgical treatment and irradiation with radium, four of these are now living and eight have died. Radium was the only treatment given 12 patients (or 6.15 per cent) — one of these is living and nine have died. Radium and roentgen rays

together were used without any surgical treatment in seven cases (or 3.58 per cent) — two of these patients are living and four have died. Irradiation with roentgen rays alone was used in two cases (or 1.02 per cent) — these two patients have not been traced. No treatment at all was given in 47 cases (or 24.10 per cent) of the patients in this group, three are still living and 30 are known to be dead.

SUMMARY

This study is based on 195 cases of epithelioma of the penis which were encountered at The Mayo Clinic from the beginning of 1907 to January, 1932. A large proportion of the total, 47 patients in all, received no treatment at the Clinic.

TABLE IV — SUMMARY OF TREATMENT GIVEN

Type of treatment	Total	Per cent	Living at last report	Per cent	Died	Per cent	Not traced	Subsequent life years						Group			
								1 to 5	5 to 10	10 to 15	15 to 20	20 to 25	Not stated	I	II	III	IV
Surgical only	62	31.79	21	29.57	34	32.07	7	33	6	8	5	2	1	19	10	16	17
Surgical and roentgen ray	37	18.97	26	36.61	11	10.37	0	23	10	4				10	9	6	12
Surgical, radium, and roentgen ray	15	7.69	5	7.04	10	9.43	0	10	3	1				4	3	1	7
Surgical and radium	13	6.66	5	7.04	8	7.54	0	9	3		1			3		5	5
Radium alone	12	6.15	3	4.22	9	8.49	0	12	1					1	1		10
Radium and roentgen ray	7	3.58	3	4.22	4	3.77	0	6	1						2	1	4
Roentgen ray alone	2	1.02	0		0		2										2
None	47	24.10	8	11.26	30	28.30	9	31	3		1		3	4	11	3	29
Total	195		71		106		18	124	27	13	6	3	4	41	36	32	86
	Total traced		Now living														
Surgical only	45	32.14	11	32.35	34	32.07		29	5	5	3	2	1	13	9	12	11
Surgical and roentgen ray	22	15.71	11	32.35	11	10.37		13	5	4				4	5	6	7
Surgical radium and roentgen ray	12	8.57	2	5.88	10	9.43		10	1	1				2	3	1	6
Surgical and radium	12	8.57	4	11.76	8	7.54		9	2		1			3		4	5
Radium alone	10	7.14	1	2.94	9	8.49		10							1		9
Radium and roentgen ray	6	4.28	2	5.88	4	3.77		5	1						2	1	3
Roentgen ray alone	0																
None	33	23.57	3	8.82	30	28.30		28	1		1		3	2	8	2	21
Total	140	71.79	34		106			104	15	10	4	3	4	24	28	26	62

Sixty-two patients received surgical treatment alone at the Clinic. The remainder received a combination of surgical treatment and irradiation with roentgen rays, surgical treatment and irradiation with both radium and roentgen rays, surgical treatment and irradiation with radium, irradiation with radium alone, irradiation with radium and roentgen rays, or irradiation with roentgen rays alone. The cases have been divided into groups depending on the extent of the primary lesion and the presence or absence of metastasis. They have also been divided according to the microscopic grade of the lesion. One hundred and six patients have died, 34 are known to be still living, and the remainder have not been traced up to the time of the present writing, although the majority of these were well when last heard from.

The subsequent life in years has been worked out for all patients. We find that five have lived from 20 to 25 years, five have lived from 15 to 20 years, and the remainder for shorter terms since the time of the first treatment.

It is obviously incorrect to contrast the results in those cases in which patients received only surgical treatment, or were treated by irradiation alone, with the results in those cases in which patients received a combination of surgical treatment and irradiation, as the group of cases in which patients received surgical treatment alone is made up of cases seen prior to 1915, when treatment by irradiation was instituted at the Clinic. The results have been good when we consider that the data go back over a period of 25 years and deal with patients of the cancer age whose life expectancy is ordinarily less, many have died of other complications and seven of the group had malignant lesions of other parts of the body. Further, it is interesting to note that these good results have accrued mainly from conservative surgery. Considering the total experience of these patients here and elsewhere, only 45 (or 23.07 per cent) received radical

surgical treatment, 84 (or 43.07 per cent) received conservative surgical treatment, and 50 (or 25.64 per cent) received minor surgical treatment.

CONCLUSIONS

Epithelioma of the penis is a slow-growing neoplasm which is inclined to remain superficial for a long time, to metastasize late, and, when such metastasis does occur, to affect the inguinal nodes. The slow growth and accessibility of the lesion render it amenable to surgical treatment and to irradiation with radium and roentgen rays, either alone, or probably best in combination. The type of surgical procedure obviously depends on the extent of the lesion and the presence or absence of metastasis, and to some extent also on the wish of the patient. In inoperable cases, irradiation alone accomplishes a great deal in the way of palliation. Obviously the earlier the condition can be diagnosed, the better the chance of permanent cure by a combination of surgical treatment and irradiation.

Circumcision in infancy must receive more attention as a means of preventing malignant disease of the penis (10).

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This study is based on 195 cases of epithelioma of the penis which were encountered at The Mayo Clinic from the beginning of 1907 to January, 1932. A large proportion of the total, 47 patients in all, received no treatment at the Clinic

TABLE IV — SUMMARY OF TREATMENT GIVEN

Type of treatment	Total	Per cent	Living at last report	Per cent	Died	Per cent	Not traced	Subsequent life years						Group			
								1 to 5	5 to 10	10 to 15	15 to 20	20 to 25	Not stated	I	II	III	IV
Surgical only	62	31.79	21	29.57	34	32.07	7	33	6	8	5	2	1	19	10	16	17
Surgical and roentgen ray	37	18.97	26	36.61	11	10.37	0	23	10	4				10	9	6	12
Surgical, radium, and roentgen ray	15	7.69	5	7.04	10	9.43	0	10	3	1				4	3	1	7
Surgical and radium	13	6.66	5	7.04	8	7.54	0	9	3			1		3		5	5
Radium alone	12	6.15	3	4.22	9	8.49	0	12	1					1	1		10
Radium and roentgen ray	7	3.58	3	4.22	4	3.77	0	6	1						2	1	4
Roentgen ray alone	2	1.02	0		0		2										2
None	47	24.10	8	11.26	30	28.30	9	31	3		1		3	4	11	3	29
Total	195		71		106		18	124	27	13	6	3	4	41	30	32	86
	Total traced		Now living														
Surgical only	45	32.14	11	32.35	34	32.07		29	5	5	3	2	1	13	9	12	11
Surgical and roentgen ray	22	15.71	11	32.35	11	10.37		13	5	4				4	5	6	7
Surgical, radium and roentgen ray	12	8.57	2	5.88	10	9.43		10	1	1				2	3	1	6
Surgical and radium	12	8.57	4	11.76	8	7.54		9	2		1			3		4	5
Radium alone	10	7.14	1	2.94	9	8.49		10							1		9
Radium and roentgen ray	6	4.28	2	5.88	4	3.77		5	1						2	1	3
Roentgen ray alone	0																
None	33	23.57	3	8.82	30	28.30		28	1	1		3	2	8	2	2	21
Total	140	71.79	34		103			104	15	10	4	3	4	24	28	26	62

Radiological Units consisting of six members including the chairman

3 The sub-committee shall elect its own chairman and secretary from amongst its members

4 The sub-committee shall report on the progress of dosage measurements and prepare the program to be submitted to the main committee. The report shall be published, and circulated to members of the main committee at least six months before the meeting of a Congress

Members of the Sub-committee—I Solomon, *Chairman*, L S Taylor, *Secretary*, H Behnken, E A Owen, E Pugno-Vanoni, R Sievert

Members of the International Committee for Radiological Units Preparing the Above

Report—P Scherrer, Switzerland, *Chairman*, H Koenig, Switzerland, *Vice-chairman*, H Holthusen, Germany, and E A Owen, Great Britain, *Hon Secretaries*, H Behnken, Germany, F Béhounek, Czechoslovakia, A Bouwers, Holland, E C Ernst, U S A, N S Finzi, Great Britain, G Guében, Belgium, L Haas, Hungary, H M Hanson, Denmark, S A Heyerdahl, Norway, D den Hoed, Holland, F Holweck, France, A Liechti, Switzerland, M Ponzio, Italy, E Pugno-Vanoni, Italy, R M Sievert, Sweden, I Solomon, France, L S Taylor, U S A, K T Watanabe, Japan

Approved by the Fourth International Congress of Radiology, St Moritz, July 31, 1934

RECOMMENDATIONS OF THE INTERNATIONAL COMMITTEE FOR RADIOLOGICAL UNITS (ZÜRICH, 1934)

SECTION A

1 The International Unit of Quantity of X-radiation shall be called the "roentgen" and shall be designated by the symbol "r"

2 The International Unit of X-radiation shall be the quantity which, when the secondary electrons are fully utilized, and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at 0°C , and 76 cm mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current

SECTION B

3 Dosage measurement shall be made in roentgens Dosage rate shall be expressed in roentgens per minute

4 All dosage measurements shall distinguish between the air dose which does not include scattered radiation, and the effective dose which includes scattered radiation

5 The specification of dosage shall include a statement of the quality of the radiation For exact physical measurements, the quality of the radiation may be specified in terms of the complete absorption curves in copper or aluminum For most practical purposes, the quality may be expressed by the first and the second half value layers of the same materials

6 The specification of dosage shall also include

- (a) Dosage rate,
- (b) The total time of irradiation and the intervals between the times of irradiations,
- (c) Material and thickness of filter,
- (d) Target-skin distance,
- (e) The dimensions and number of ports of entry

7 The practical instrument used to measure x-ray quantity shall be called a dose-meter, and shall be calibrated in roentgens

8 The calibration of a dose-meter shall be tested periodically by a recognized testing laboratory, over the range of wave lengths for which it will be used

9 The constancy of the calibration of a dose-meter shall be tested by the ionization produced, under fixed conditions, by a definite quantity of radium element

10 Dose-meters should be independent of the wave length within the range for which they will be used

Note—For details of standard measurements and the calibration of dose-meters, attention is directed to the joint reports issued by the National Standardization Laboratories

SECTION C

The Committee is of the opinion that the ionization measurement of gamma radiation is promising The necessity for further investigation is urged to discover if any difficulties of a fundamental character exist in connection with the experimental realization of the roentgen over the widest possible range of wave lengths

RULES GOVERNING THE SELECTION AND WORK OF THE INTERNATIONAL COMMITTEE FOR RADIOLOGICAL UNITS

1 The International Committee for Radiological Units shall be constituted of two representatives from each country sending delegates to the Congress When a country has a central X-ray Standardization Laboratory, it may, in addition, send a representative of that laboratory Of the representatives from a single country, at least one must be a radiologist and one a physicist

2 There shall be a standing sub-committee of the International Committee for

discussion In a restricted sense, the mesentery is, then, that part of the duplicated peritoneal lining which extends from artery The U-loop cannot move freely in a lateral direction, because its apex is fixed to the umbilicus by means of the



Fig 2 Barium enema showing roentgen signs of active tuberculous infiltration of the cecum and ascending colon

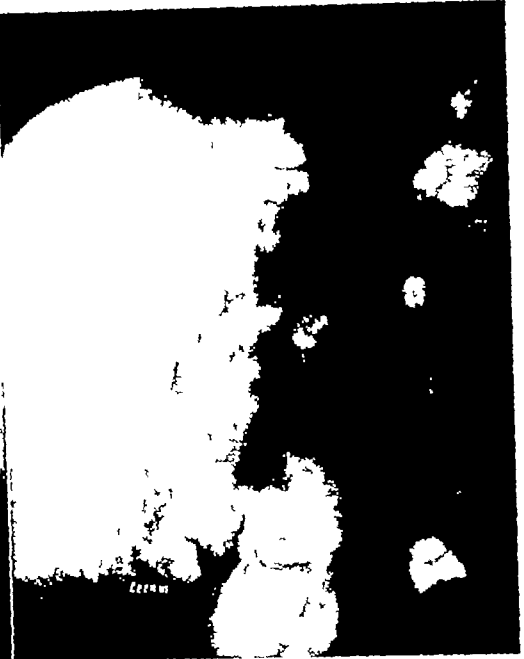


Fig 3 The same as Figure 2 Visualization of the cecum in the left lateral position by means of barium and air inflation

the radix mesenterii to the small intestine. It originates on the left border of the second lumbar vertebra and extends obliquely toward the right iliac fossa, ending just above the right sacro-iliac region. All of these structures show numerous anatomic variations, some of which are of clinical importance. To understand this, it is advisable to review briefly their embryologic development.

Maldevelopments and Variations—In the fifth week of embryonic life, the digestive tract is represented by a long duct; the fore-gut is fixed in the mid-line of the body by the ventral and dorsal mesenteries (Hubeny). The mid- and hind-guts are suspended from the posterior body wall only by their dorsal mesenteries; the ventral mesenteries have disappeared. The mesentery of the mid-gut is long, and the intestinal tube forms a long U-loop which is supplied by the superior mesenteric

vitelline duct. However, it is able to rotate around its base, where the two limbs of the U are close together. After the fifth week the mid-gut increases in length very rapidly; its mesentery becomes fan-shaped and capacious, except at the base of the loop, where it is reduced to a narrow isthmus through which the superior mesenteric artery passes. At the beginning of the third month the U-shaped loop twists around the isthmus from right to left, thus elevating the distal part of the hind-gut, which becomes attached on the left side, as the splenic flexure of the colon. The rest of the colon proximal to this swings over the front of the abdominal cavity from left to right, becoming attached to the structures of the posterior body wall along a line extending from the left to the right kidney, and thence down to the right iliac fossa. Thus explains why a part of the small gut (second and third parts of

THE MESENTERY¹

A RADIOLOGIC STUDY

By R. POMERANZ, M.D., *Newark, N. J.*

CONSIDERED anatomically, the mesentery represents two layers of peritoneal lining separated by loose connective tissue in which branches of arteries, veins, and lymphatics extend to

the intestinal tract. Therefore, broadly speaking, we should include the following structures: ligamenta, gastro-hepaticum, hepatoduodenale, gastro-lienale, gastro-colicum, bursa omentalis, mesocolon trans-



Fig. 1. Postero-anterior and lateral views of a rabbit 150 days after an intraperitoneal injection of 10 c.c. of thorotrast. (A) Outline of the peritoneal lining of the abdominal cavity. (B) Lymphatic sacs in the chest. (C) Lymphatics of the mesentery.

¹ Presented before the Fourth International Congress of Radiology, Zürich, Switzerland, July 24-31, 1934.

versum, and sigmoideum, besides the radix mesenterii, which is the chief object of our

mesentery has been attempted and accomplished by several investigators. Held, Menville, Pomeranz, and others have injected colloidal thorium into the abdominal cavity of animals, which thorium has been retained by the reticulo-endothelial cells, thus giving a very good radiographic outline of the peritoneal lining of the entire abdominal wall and of the mesentery (Fig 1). These experiments demonstrate the interrelationship of the lymphatic systems of the abdominal cavity and of the chest; they also demonstrate the practicability of this method in retroperitoneal tumors. The difficulties are, first, that the opaque medium is not eliminated, and secondly, that the thorium is slightly radio-active and, as such, is not suitable for human beings.

I have performed animal experiments, using the now available iodide preparations such as skiodan, hippuran, and others for this purpose. However, after intraperitoneal injection of a few cubic centimeters of these preparations, the absorption was so rapid that for practical purposes no proper visualization could be accomplished. These experiments will be reported in detail at a later date.

The only available method is the indirect study of the mesentery in human beings by means of visualization of the intestines with a barium meal or a combination of barium and air. On radiographic and fluoroscopic study of the intestines, one should observe the following: (1) Distribution of gas in the abdomen, (2) position of the gut in various views, (3) passive mobility on palpation, (4) motility, (5) topical relationship of the gut with the other abdominal organs (kidneys, liver, and spleen), also in the lateral view if necessary, (6) correlation of the roentgen symptoms with the type of individual.

Congenital Anomalies—A knowledge of intra-abdominal malformations is important both to the surgeon and to the internist. For example, the pre-operative knowledge of a non-rotated cecum situated high under the liver, in a case of an acute appendicitis, may be instrumental in sav-



Fig 6 Same as Figures 4 and 5

ing the life of the patient, as it will shorten and simplify the operation. Many authors have described the various forms of malformation and their clinical and radiologic significance. The most important malformation is the mesenterium commune. This is due to failure of the navel loop of the small intestines to rotate; it may be the cause of intussusception or obstruction, or both. The recognition of the varying length of the mesentery by the position and passive mobility of the gut may be helpful in the localization of pain in the abdominal cavity. The roentgen symptoms were recently described by Kadrnka and others.

Acquired Anomalies—These are caused by fibrous changes of the mesentery and can be due to: (1) Post-operative adhesions, (2) fibroplastic tuberculous lesions (Figs 2 and 3), (3) neoplastic shrinkage, (4) post-radiation fibrosis.

Inflammatory Changes—We know that the distribution of the gas in the abdomen



Fig 4. G B, male baby 3 months old, showing gas compression of sigmoid causing regurgitation of the enema fluid. Diagnosis: Intussusception of ileum into the colon.



Fig 5. Same as Figure 4.

the duodenum) is situated behind the transverse colon, while the rest (jejunum and ileum) lies freely in the abdomen, below the transverse colon. It is attached with its radix mesenterii posteriorly along the line described above, extending obliquely from the second lumbar vertebra on the left side to the right sacro-iliac region. The free mesentery is covered on both sides by the peritoneal lining; the attached one, on its anterior surface only. Variations in the four major processes involved in this embryonic change (migration, rotation, descent, and fixation) may occur by excess or defect. It is impossible to cite all the current developmental anomalies. We shall discuss below those most important for the surgeon and the clinician.

Physiology—The function of the mesentery is twofold. It obviously serves as a medium of lymphatic and blood supply to the gut, and it may also be considered as a medium for the fixation of the intestines to the abdominal wall. The latter function is doubtful, in the opinion of Alvarez, who asserts that the intestines are floating freely in the abdominal cavity.

At the present status of our knowledge the direct visualization of the mesentery is impossible. No method has been devised which will enable one to recognize the vascular structures of the mesentery. Even if a suitable opaque medium were available, the injection would have to be made so near the vital organs as to render the procedure dangerous to life. The visualization of the peritoneal lining of the



Fig 8 A E, male, 60 years old Barium enema showing poor, feather-like filling of the ascending colon The palpable mass is outlined at the region of the iliac fossa



Fig 9 Same case as Figure 8 Air inflation of the colon

Case 2 Female baby, S P, 14 months old, ill for 24 hours prior to the x-ray examination Barium enema (Fig 7) showed good filling of the entire colon up to the ascending colon The cecum and ascending colon showed a sharply defined defect, around which the barium flowed to reach the proximal end of the colon The x-ray diagnosis was Intussusception of the ileum into the ascending colon

Operative Findings by Dr Danzis—The ileum, 18 inches from the ileocecal junction, was intussuscepted into itself The intussuscepted portion was then intussuscepted into the cecum, reaching as far as the hepatic flexure of the colon At this point there was a small segment of the ileum markedly indurated, forming a constriction ring, and the serosa, at that area, was deeply injected There was a chain of enlarged glands at the ileocecal junction

Case 3 Male, A E, 60 years old, had an attack of appendicitis two weeks prior to the x-ray examination On palpation one could find a large mass in the right lower quadrant about three inches in diameter, resilient, not freely movable, and not tender to pressure Barium enema (Fig 8) revealed multiple diverticula of the entire colon The barium fluid reached the ascending colon without difficulty at that point the colon and cecum were narrow, feather-like in appearance, and incompletely filled Some of the barium passed into the terminal ileum The cecum showed a high fixation The inflation of air (Fig 9) and the subsequent oral meal (Fig 10) gave the same findings The terminal ileal loop was better visualized by the oral meal and appeared to be partly compressed and fixed

Operative Findings by Dr Dwyer—The palpable mass on the right side consisted of the terminal ileum loops, the cecum and

is a very important diagnostic symptom. One should, therefore, try to visualize the abdomen in the upright and prone posi-

The radiographs (Figs 4, 5, and 6) reveal a small amount of barium filling out the rectum and the sigmoid. The sigmoid



Fig 7 S P, female baby, 14 months old. Barium enema showing large sharply defined defects of the cecum and ascending colon caused by intussusception of ileum into the colon. Compare these roentgen symptoms with those of Figures 4, 5 and 6.

tions, and in the postero-anterior and lateral views, as it will often enable one to localize the point of obstruction.

Let me cite at this point two cases of intussusception in children and one case of inflammatory tumor in an adult with their respective operative findings. (Courtesy of Dr. Weinberg, Dr. Danzis, and the X-ray Department of Newark Beth Israel Hospital.)

Case 1. Male baby, G. B., three months old, became ill less than 48 hours prior to the x-ray examination. The abdomen was distended. Barium enema was attempted, and the fluid regurgitated immediately after the injection. The injection was repeated with a small catheter, and even then the fluid was immediately returned

extended upward toward the mid-line and showed obstruction in its upper end, apparently due to gas compression. The right and left sides of the abdomen showed several overlapping widened loops of the gut filled with gas. The radiologic diagnosis was as follows: Probable intussusception of the ileum into the colon up to the transverse colon, with compression of the sigmoid.

Operative Findings by Dr. Danzis—Free fluid in the peritoneal cavity. A large sausage-shaped tumor (right side) consisting of the ileum, cecum, and appendix, which were intussuscepted into the ascending and transverse colons, filled up the entire transverse colon to the splenic flexure.

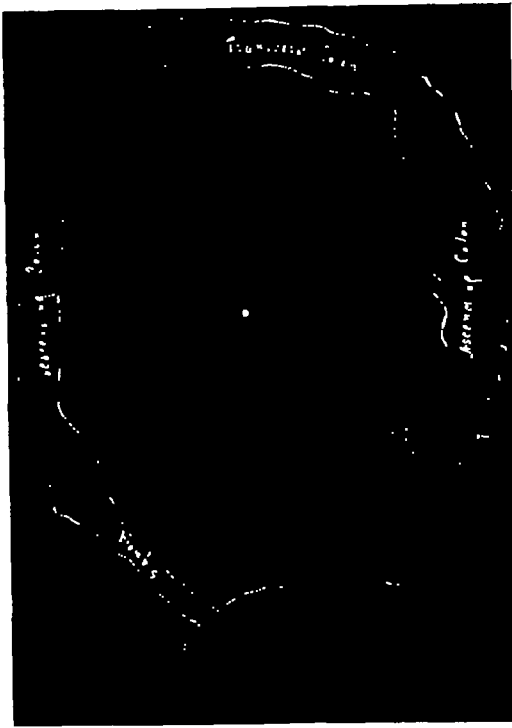


Fig 11 M B, male 38 years old Sketch of barium enema reproduced from the original films, showing the displacement of the main parts of the colon, due to the cystic growth of the mesocolon and mesosigmoid Mesenteric cyst

after complaining for the last 18 months of becoming stout, gaining weight, and of an enlargement of his abdomen I examined the patient in the fluoroscopic room The abdomen was very large, measuring about fourteen inches in diameter, and showed the presence of encapsulated fluid The barium enema showed no defects of the colon, but did indicate marked displacement of each of its segments in different directions, *i e*, the sigmoid was displaced to the left side, the transverse colon, upward, and the ascending colon to the right side This indicated a mass situated probably in the mesentery (mesocolon and mesosigmoid) showing an expansive growth (Fig 11) From this examination, I suggested that the tumor was probably due to a mesenteric cyst

Operative Findings by Dr Greenfield—The abdomen was uniformly enlarged On opening the peritoneum, there was found a large fluctuating mass (Fig 12)



Fig 12 Photograph of the anatomic specimen of the mesenteric cyst wall

which filled out the entire abdominal cavity, with the omentum attached to its anterior surface This mass originated from the mesentery and contained a large amount (1 liter) of serosanguinous fluid, cheesy material, and clotted blood Another small cyst within the larger one contained a moderate amount of yellowish fluid resembling pus

Microscopic Diagnosis—A very vascular fibromyxoma of the mesentery was found, with cystic degeneration and chronic infection (Figs 12 and 14)

Neoplastic Changes—Secondary neoplastic changes of the mesentery may be due to primary intestinal growth or to a general peritoneal infiltration (ovarian tumors)

Case 5 Male, T C, 50 years old, complained of some loss of weight and the presence of a mass in the right lower quadrant One year prior to the examination an appendectomy had been performed On palpation, a movable mass, not tender to pressure and about three inches in diameter, could be noted in the right lower quadrant Barium enema showed an irregular narrowing of the sigmoid—it was pulled over to the right side (Fig 15) This defect of the sigmoid measured about two and a half inches in length At the same time one could notice the defect of the cecum The air inflation after the barium enema showed normal rugæ of the sigmoid indicating that the tumor was

ascending colon being matted together by extensive and apparently not very old adhesions. The serosa of the gut and of

x-ray symptoms, therefore, resemble those of inflammatory ileus, recognized by the distribution of gas, horizontal levels, etc



Fig 10 Same case as Figures 8 and 9. Oral barium meal shows better filling of the terminal ileal loops, cecum, and ascending colon. The latter shows high fixation and has a feather like appearance, indicating an inflammatory process.

the mesentery was injected. The appendix was adherent to the cecum, markedly thickened, and somewhat injected. After separating the adhesions, the entire mass dissolved itself into the respective loops described above.

All three patients made uneventful recoveries.

In mesenteric thrombosis the clinical symptoms result from the defective blood supply which causes paralytic ileus. The

Neoplastic Changes—Primary tumors of the mesentery are rare and are seldom diagnosed pre-operatively by means of the x-ray examination. I had an occasion to examine the following case of mesenteric cyst, reported through the courtesy of Dr Greenfield and Dr Nash, and the X-ray and the Pathologic departments of the Newark Beth Israel Hospital.

Case 4 M B, male, 28 years old, was sent to the hospital for observation,

tract These calcific deposits should be differentiated by the following (1) Location in the antero-posterior and lateral

grouped together Urinary calculi are more solid in appearance and are projected in the course of the genito-urinary



Fig 15 T C, male, 50 years old Barium enema shows filling defects of the cecum and sigmoid Mass outlined The ragged appearance of the defect and the subsequent visualization of normal rugae of the mucous membrane of the sigmoid indicated an infiltration around the wall of the sigmoid Operative diagnosis Gelatinous carcinoma of the cecum growing around the sigmoid

positions, (2) mobility on palpation under the screen, (3) radiographic appearance The mesenteric calcifications are situated laterally and anteriorly in relation to the spine as a rule they have a glandular appearance, are irregularly calcified, and consist of multiple calcium deposits

tract In the lateral view, the pelvic calculi are projected on the body of the second lumbar vertebra Calcified cartilages are situated in the upper abdomen and consist of two parallel, faintly calcified shadows Vascular calcifications are also uniform but of lesser density and are situ-

located at the ileocecal region and grew around the sigmoid

Operative Findings—The tumor in-

Radiologic Diagnosis—Early neoplastic tumor of the sigmoid

Operative Findings by Dr. Haussling—

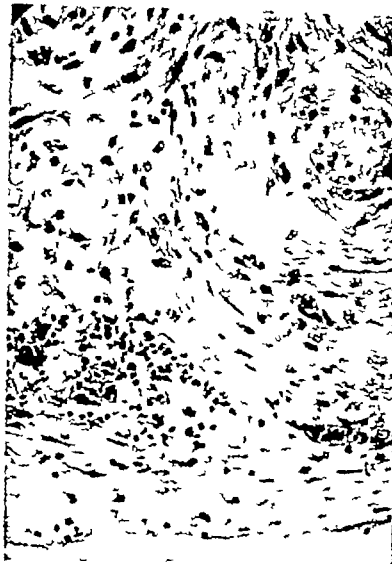


Fig 13 Photomicrograph of the wall of the cyst showing many fibroblasts and round-cell infiltrations



Fig 14 Photomicrograph of the wall of the cyst, showing areas of myxomatous degeneration

involved the cecum, terminal ileum loop, and the sigmoid which was adherent to the mass. The mucous membrane of the latter was normal.

Microscopic Diagnosis—The gelatinous type of carcinoma probably originated from the cecum.

Case 6. Male, C. R., 55 years old, in good general physical condition, gave a history of the passage of bloody stools on one occasion, about two weeks prior to the examination. The x-ray examination with the barium meal revealed no defects, nor did two examinations by means of barium enemas. No mass was palpable in the abdomen. At a third examination of the colon by means of barium and air² (Fig 16), a small defect measuring about one and a quarter inch in length could be noted in the right lower quadrant at the level of the iliac fossa. Even then, only a small resistance was palpable at that region and no tenderness could be elicited.

² All of these examinations were carried out within a week.

small mass measuring about one and one-half inches in length, was found in the sigmoid which was pulled through a left abdominal incision. Two glands were palpable, one in the mesentery and the other next to the abdominal aorta.

Microscopic Findings—Adenocarcinoma of the sigmoid.

Comments—I wish to emphasize the necessity of differentiating the inflammatory from the neoplastic changes in the mesentery. Any inflammatory lesion, whether due to infection, non-obstructive ileus, or intussusception, shows radiographically a feather-like appearance of the nearby gut. In a neoplastic change of the mesentery, no roentgen symptoms can be observed except for the defects of the corresponding gut. This principal difference should be kept in mind when interpreting the films.

Mesenteric Calcifications—One very often finds calcific deposits in the abdomen in the course of general routine examinations for disease of the genito-urinary

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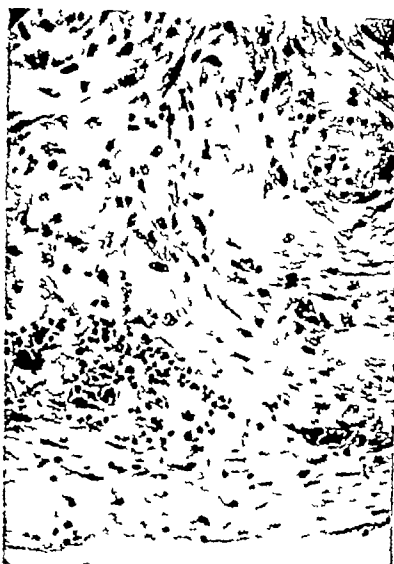


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the mesentery has been emphasized. An inflammatory process of the mesentery is indicated by the feather-like appearance of the corresponding segments of the intestines.

I am indebted to Dr H S Martland for his kind help in the preparation of the reproductions necessary for this paper.

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Fig 16 C. R. male 55 years old Barium and air inflation showing a small canalized defect of the sigmoid about one inch long. The sigmoid was displaced to the right side, indicating a long mesosigmoid. Pre-operative diagnosis: Early probably malignant newgrowth of the sigmoid. Operative findings: Adenocarcinoma of the sigmoid.

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means of an opaque medium—thorotrast—is successful in animals. In human beings this is impractical only because of the lack of a suitable opaque medium. Thorotrast is not applicable to human beings because of its late radio-activity, although it could be used in proved malignant lesions of the abdominal cavity.

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the mesentery has been emphasized. An inflammatory process of the mesentery is indicated by the feather-like appearance of the corresponding segments of the intestines.

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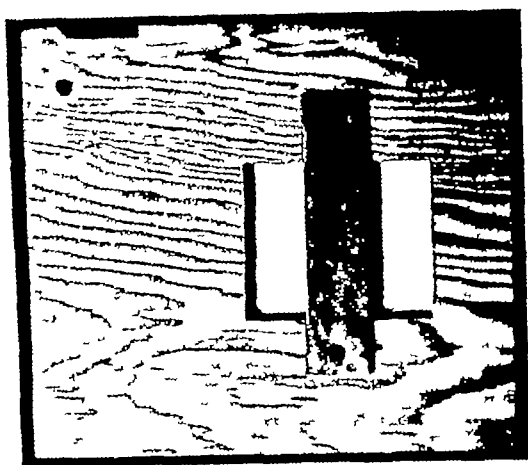


Fig 2 Plate divider used in combination with the diaphragm to permit unlike techniques to each hemithorax

The sheet of lead is mounted upon a piece of plywood in such a position that when it is pushed all the way in to the filter stop the center of the opening is exactly on the line of the central ray to the midpoint of the film. Under this condition merely to be sure the tube is pointed correctly, *i.e.*, that the central ray is directed to the center of, and is normal to, the film, assures that the coverage is correct. Experience has indicated that a sheet of lead cut to the proper size but not mounted on a wood backing is unprotected from a small amount of banging around, which sooner or later destroys the necessary accuracy of alignment and position.

The Exposure Divider—Quite often it is desirable and even necessary to utilize a different quality of radiation on one side of the chest than on the other. Thickened pleura on old pneumothorax and other cases, deficient aeration in phrenicotomy with compensatory contra-lateral emphysema, and other conditions may require a small change in roentgen-ray quality to obtain the best roentgenogram of each lung, while thoracoplasties, atelectatic lungs and many other conditions require a comparatively heavy penetration to demonstrate underlying conditions. In the former class of cases a compromise technic is often adopted for a single exposure,



Fig 3 An example of the use of the plate divider in which the left lung was radiographed with a penetration of 14 K V higher than the right. Note the difference in shoulder and neck shadows and the absence of any line of division.

resulting in a plate which on the one side is a bit too dark and on the other too light. With the latter, two plates are often taken, one with a heavy technic for the dense side and the other with a lighter exposure for the more normal condition, in which case one-half of each plate is of no use and represents an economic loss. Though this may be mitigated by cutting a film down the middle (or using 7×17 films) and exposing each half separately to its proper technic, the handling of the parts in processing, viewing, and filing is bothersome. By using a plate divider such as that shown in Figure 2 mounted in the second filter slot of the tube stand and in combination with the chest shield described above, the proper technic for each hemithorax may be exposed to a single film without affecting the other half.

A strip of sheet lead sufficiently wide to cover something more than half the width of the opening in the chest shield, and whose edges are exactly parallel, is carefully mounted on a piece of plywood perpendicular to the bottom edge. The

A DIAPHRAGM AND PLATE DIVIDER FOR CHEST ROENTGENOGRAPHY

By CLARENCE J ZINTHEO, JR., B Sc, *Richmond Highlands, Washington*
Radiographer at the Firland Sanatorium, Richmond Highlands, Washington

THE usefulness of cones on most radiographic work is quite generally appreciated. However, on chest roentgenograms many laboratories do not use any device to limit the beam of incident radiation, partly because a diaphragm of the proper size and shape is not usually available and partly because the large amount which the density caused by scattered radiation adds to the total density of the film is not widely known. Wilsey (2) has recently indicated that in making a chest roentgenogram, scattered radiation may amount to 50 per cent or more of the total radiation reaching the film. In an earlier work (3) he found that, aside from the use of a Potter-Bucky diaphragm, scattered radiation from a given body could be reduced, and the quality of the resulting roentgenogram improved most efficiently by decreasing the area of exposure with cones and similar diaphragms. Test plates on chests taken here with a proper shield and compared with otherwise identical exposures of the same patients taken without the diaphragm show a definite improvement which might best be described as a cleaner film of slightly more contrast.

A recent paper by Dr Rhinehart (1) called attention to the fact that the size and shape of the opening of the diaphragm should be such that the film exposed is just covered. Therefore, a sheet of one-eighth of an inch of lead should have a rectangular opening cut into it of such dimensions that, when it is placed in the proper filter slot of the tube stand, the beam of rays will no more than cover a 14 × 17 cassette at the distance used (Fig 1). Conditions are not the same in different laboratories and so the exact dimensions of the opening will vary, but they may be easily computed with the aid

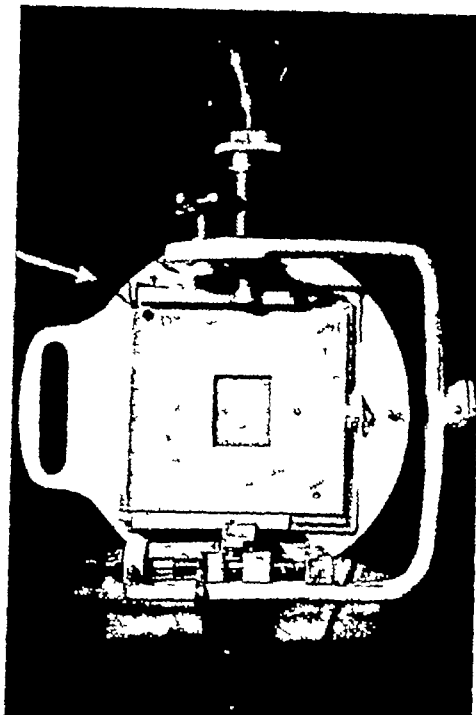


Fig 1 Diaphragm for chest roentgenography mounted in position

of Figure 4. The size of the opening in the shield P is given by the equation $P = I \frac{D}{F}$ where I is the dimension of the film covered, F is the focal-film distance, and D is the distance from the focal spot to the face of the shield nearest the film. Thus if the focal-film distance is 60 inches and it is $7\frac{1}{4}$ inches from the focal spot to the shield, an opening of $1\frac{3}{64} \times 2\frac{3}{64}$ inches will just cover a 14 × 17 film. An inch or so margin to spare should be left around the film—the portal might be cut to $1\frac{7}{32} \times 2\frac{9}{32}$ inches. Such an opening might seem very small to expose all of such a large film, but it will be found to be correct in actual practice.

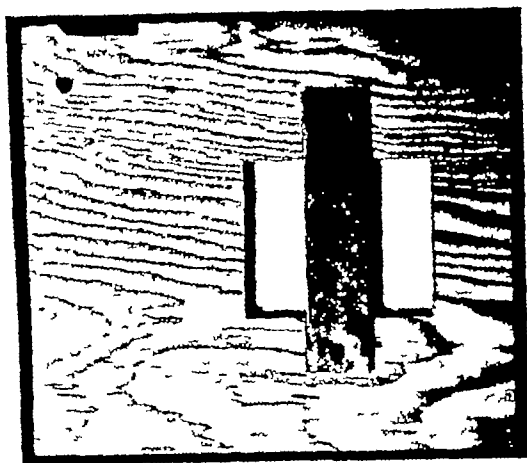


Fig 2 Plate divider used in combination with the diaphragm to permit unlike technics to each hemithorax



Fig 3 An example of the use of the plate divider in which the left lung was radiographed with a penetration of 14 KV higher than the right. Note the difference in shoulder and neck shadows and the absence of any line of division

The sheet of lead is mounted upon a piece of plywood in such a position that when it is pushed all the way in to the filter stop the center of the opening is exactly on the line of the central ray to the mid-point of the film. Under this condition merely to be sure the tube is pointed correctly, *i.e.*, that the central ray is directed to the center of, and is normal to, the film, assures that the coverage is correct. Experience has indicated that a sheet of lead cut to the proper size but not mounted on a wood backing is unprotected from a small amount of banging around, which sooner or later destroys the necessary accuracy of alignment and position.

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A strip of sheet lead sufficiently wide to cover something more than half the width of the opening in the chest shield, and whose edges are exactly parallel, is carefully mounted on a piece of plywood per-

position is such that when the right end of the wood mounting is butted to the filter stop in the tube stand, the left edge is

In use, the divider is positioned with the notch butted to the clip and the exposure of the left lung made, the transformer con-

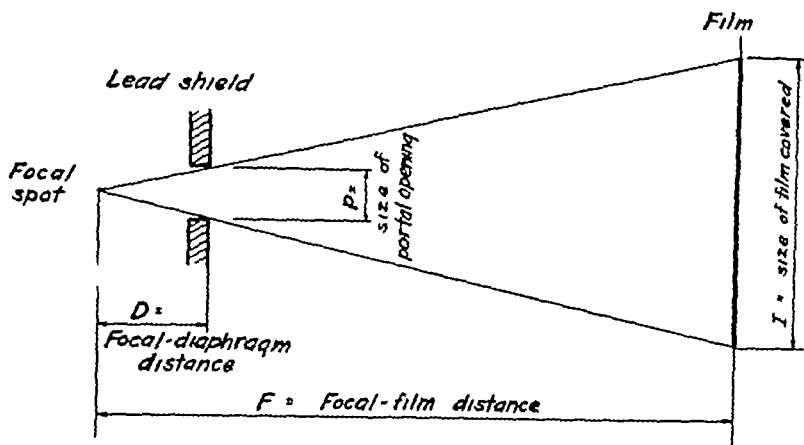


Fig 4 Geometrical arrangement for computing the size of the diaphragm opening

exactly opposite the median line of the shield opening or very slightly to the right of this line. A small notch is then cut in the wood so that when the device is drawn out and butted to the clip (seen at the upper left-hand corner of the chest shield in Figure 1) or other similar stop, the right edge of the lead is exactly opposite the median line of the shield opening or very slightly to the left of it.

By making the edges come slightly to the right and left of the median line an overlap of exposure on the chest plate is obtained which should be not wider than one inch. With the patient properly placed, the division of technic is obtained on the spine and mediastinum where the double exposure caused by the slight overlap on the film seems to be an advantage. Figure 3 shows the results of using the divider on a thoracoplasty case in which a penetration of 14 K V more was used on the side operated upon. Notice that no line of demarcation between the two exposure technics can be seen. The difference in penetration is demonstrated in the reproduction by the appearance of opposite sides of the neck and the bones of the shoulder.

When the controls are changed, the divider is pulled up to the stop by a string leading to the control booth, and the exposure of the right lung is made. It is found entirely practicable to make both exposures and change the controls while the patient holds the one breath, with a total elapsed time of about five seconds being all that is required. When a magnetic stereo trip is available on the tube stand it may sometimes be adapted to shift the divider.

Some measurements on the transmission of roentgen rays produced by the potential commonly used for chest work through one-quarter inch, 3 ply fir wood, showed a decrease in otherwise unfiltered radiation of 43 per cent in intensity and a change in effective wave length corresponding to filtration with 0.28 mm aluminum. To eliminate this change, portals of sufficient size must be cut in the wood supports of both the chest shields and plate divider. A piece of black paper over the opening of the chest shield serves to cut off the visible light and prevent a possible sudden start by an unwary patient from the reflected flash of the exposure.

SUMMARY

REFERENCES

1 A shield or diaphragm and its method of preparation is described for use in chest roentgenography. Comparison of otherwise identical plates made with and without the shield indicate that its use results in a definite improvement.

2 A divider is described which permits independent use of different exposure technics on each half of a chest film.

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SOLITARY CYSTS OF THE KIDNEY¹

By CHARLES C. HIGGINS, M.D., and EDWARD J. LAVIN, M.D., Cleveland Clinic,
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THE causative factors involved in the production of solitary cysts of the kidney have been subject to considerable discussion for a long period of time. Cysts of the kidney in general have long been recognized by anatomists. In fact, they were described by Fabry of Hilden who died in 1624, and have been studied by other distinguished anatomists, including Willis and Morgagni. However, the exact etiology has never been satisfactorily determined.

Etiologic Theories—One etiologic theory explains the development of the cyst on the basis of a mechanical blockage of the collecting tubules, with subsequent retro-dilatation. Other authors contend that it is due to a retention incident to interstitial nephritis. A third theory states that the cyst may be caused by a persistence of the "anlagen or rudiments of uriniferous tubules in the vesicular phase of development and their later expansion." Still another hypothesis is that failure of the S-shaped anlagen of uriniferous tubules to unite with the straight collecting ducts may be the causative factor. The failure of the uriniferous tubules to join the collecting ducts of higher orders (later generations) after having become detached from such ducts of a lower order is also considered as involved in the production of cysts. The belated appearance of disconnected cavities in a uriniferous tubule which had remained solid during its formation has also been presented as an instrumental factor. Finally, the secondary compression of collecting or secretory tubules caused by local inflammatory processes, as congenital syphilis, is considered by others to offer a satisfactory explanation for the production of cysts.

Recently, Hepler (1) has experimentally produced such cysts in the kidney of a

rabbit by fulgurating a papilla and ligating the artery which supplied the same pyramid. He thus produced an obstruction to urinary secretion and an anemia of the obstructed secretory tissue.

Symptomatology—In many cases, the cyst is relatively small and does not interfere with renal function, and hence produces no symptoms. In such instances, the finding of the cyst is coincidental at necropsy. When the cyst enlarges it may attain sufficient size to exert pressure on adjacent organs, or the presence of a mass may be noted by the patient. Occasionally a dull dragging or aching in the loin or hypochondrium may be experienced. As a general rule, urinary symptoms do not predominate, although in rare instances hematuria has been reported.

Diagnosis—As stated previously, the small cysts are asymptomatic, no symptoms referable to the urinary tract occur and their presence is not suspected. The larger cysts are usually confused with hydronephrosis, polycystic kidney, ovarian cysts, and occasionally renal neoplasm.

The roentgenogram may show the outline of the cyst, especially if it arises from the lower pole of the kidney and has attained moderate size. A bulging of the cyst into the renal pelvis, producing a deformity, has been reported in some cases in the literature. In certain cases in which the cyst is quite large, a definite difference in density between the cyst and the kidney can be demonstrated on the roentgenogram.

In a previous communication, a case was reported of a large solitary cyst of the upper pole of the kidney which produced downward displacement of the kidney and also definite displacement of the colon. In this instance a difference in density between the cyst and the kidney was noted roentgenographically. The findings on the

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Fig 1 Urogram showing a large globular enlargement of the lower pole of the right kidney and compressing the kidney pelvis above and the ureter toward the midline diagnosed as solitary cyst of the right kidney



Fig 2 Pyelogram of the left kidney showing a large solitary cyst of the lower pole

pyelogram, therefore, depend on the size of the cyst, its origin, and the direction in which it grows

In making the differential diagnosis, hydronephrosis, renal neoplasm, and polycystic kidney can usually be eliminated by pyelography, and pelvic examination is of value in ruling out an ovarian cyst with a long pedicle

Hydrops of the gall bladder and other lesions of the gastro-intestinal tract must also be considered. A complete roentgenographic examination, including cholecystography, can be used to eliminate these conditions

Pathology—Beyond the limits of the kidney the cyst wall is usually quite thin, in some instances, it may even be transparent. On the other hand, the cyst wall may be quite thick or even semicartilag-

nous and cases have been reported of calcification of the cyst wall. Blood vessels which are branches of the renal vessels may be seen coursing on its surface

The fluid content of the cyst is usually colorless, quite clear, and as a rule urinary constituents are absent, traces of albumin are occasionally present. When hemorrhage into the cyst occurs, the fluid assumes a bloody appearance, and subsequently thick colloid masses may form. The cyst wall is closely related to the renal parenchyma and a clear line of demarcation is difficult to perceive in some instances. The renal tissue contiguous to the cyst may present microscopic changes due to pressure, and atrophic changes in the cells may occur. However, the kidney as a whole retains its normal appearance grossly and microscopically

Treatment—Various types of treatment have been used in the surgical management

of this condition. These include incision and suture, nephrectomy and excision of the cyst.

1 Incision and suture of the cyst wall to the skin (marsupialization) has been advocated by some surgeons. In this procedure the cyst is incised and the edges of the cyst are then sutured to the skin margin. This procedure is fraught with danger, attended by unsatisfactory end-results, which include the production of an intractable fistula. In view of the excellent results secured by other surgical procedures, we believe that this operation should never be performed.

2 Nephrectomy has also had its advocates. Although in the past the kidney has been sacrificed frequently, in recent years the tendency has been toward more conservative treatment. It is conceivable that the cyst might attain sufficient size, and be so situated that a conservative procedure could not be instituted, but this is most unusual. In the presence of a co-existing lesion of the kidney, such as tumor, tuberculosis, or calculi which has caused destruction of the renal parenchyma, nephrectomy probably is necessary.

In our series of cases at the Cleveland Clinic, there has been only one instance in which nephrectomy was required for the removal of a solitary renal cyst diagnosed pre-operatively. This patient was a child who had an enormous cyst and the remaining functioning portion of the kidney was so small that it was thought best to remove it. In two other cases (Cases 2 and 3, reported here) the kidney has been removed under the impression that the lesion was a neoplasm.

3 Conservative renal surgery is especially applicable in the treatment of solitary cysts of the kidney. An extraperitoneal approach affords excellent exposure and is preferable to the intra-abdominal route. The cyst wall, although independent of the kidney capsule, is very adherent to it. In some cases by careful dissection the cyst can be removed from the kidney without removing a small

wedge of kidney parenchyma. In many cases, however, the removal of a small wedge of the kidney is necessary in order to insure removal of all the secreting surface of the cyst itself.

The usual kidney incision is made and control of bleeding is secured by digital compression of the renal vessels. By a slight release of pressure, spurting vessels may be ligated or controlled by electrocoagulation. The wedge-shaped margin of the renal parenchyma is easily reapproximated by mattress sutures of chromic catgut.

CASE REPORTS

Case 1 The patient, male, aged 58 years, entered the Clinic on Oct 15, 1931, complaining of pain in the back, frequency of urination, and pain in the right kidney region. His urinary symptoms dated back two or three years when he first noted nocturia and frequency. One year later, he had begun to complain of a constant pain in the lower back and right kidney area. The pain was occasionally sharp and radiated down the inner aspect of the thigh. For two months the scrotum had been considerably swollen.

When he was examined, he said that he was voiding every two hours during the night, but not so frequently during the day. The urine caused considerable burning and he passed only small amounts at a time. Hesitancy and diminution in the size of the stream had been progressive, and he was annoyed with considerable terminal dribbling. He had lost 28 pounds during the last six months. Dyspnea, and edema of the feet had been present for several years and recently had become more pronounced.

The man had had the usual childhood diseases and pneumonia at the age of twelve years. He said that his mother died of heart disease and that the cause of his father's death was unknown.

The patient was emaciated and cachectic. In the left supraclavicular space, there was a large, hard, fixed gland, which was not tender. The lungs were resonant.

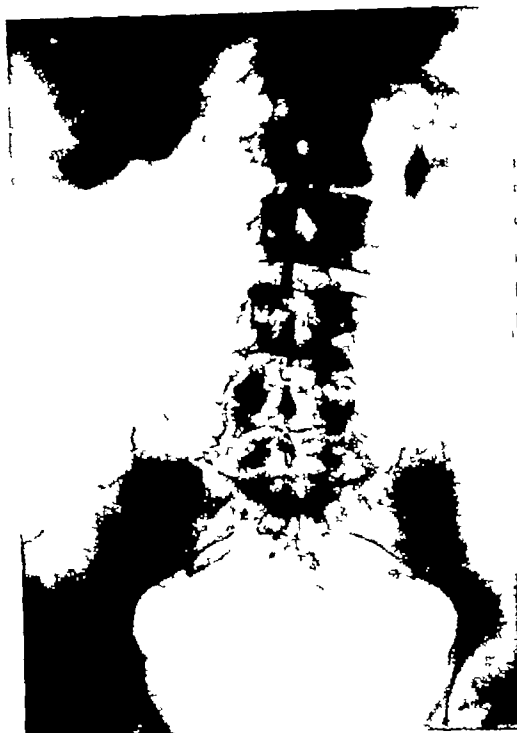


Fig 3 Urogram showing a normal left kidney pelvis. The right kidney shows hydronephrosis of the cephalic portion of the pelvis, with a large circumscribed tumor mass at the lower pole of the kidney characteristic of a solitary cyst.



Fig 4 Bilateral pyelogram showing an anomalous kidney on the left containing a solitary cyst.

throughout, but there were many crackling râles at both bases. The heart was slightly enlarged to the left, but no thrill or murmur was heard. The abdomen was scaphoid, and the liver edge was palpable. Both legs were edematous, with varicose veins. The scrotum was also swollen and edematous. The prostate was enlarged, stony hard, and fixed.

A roentgenogram of the spine showed a metastatic malignancy of the second and third lumbar vertebrae, with rather marked destruction. The urine was normal except for the presence of a trace of albumin and red blood cells two plus. The phenol-sulphone-phthalein test showed 30 per cent return of the dye the first hour and 25 per cent the second hour. There were 4,310,000 red blood cells, 78 per cent hemoglobin, and 11,600 leukocytes. The blood sugar was 88 mgm per cent and

the blood urea 27 mgm per cent. The blood Wassermann reaction was negative.

The diagnosis was carcinoma of the prostate with widespread metastasis, especially to the spine.

The patient was hospitalized and roentgen-ray therapy was instituted. One week later he died and the following findings were noted at autopsy: (1) adenocarcinoma of the prostate with metastases to spine, lungs, bronchial nodes, peri-aortic nodes, (2) hypertrophy and dilatation of the heart, (3) hydrothorax (left), (4) small cysts of the spleen, (5) a large solitary cyst of the left kidney, and (6) a small cyst of the left lobe of the liver.

The left kidney weighed 450 grams and measured $17 \times 6 \times 4$ centimeters. There was a solitary cyst 6 cm in diameter at the upper pole of the kidney which contained clear fluid. The parenchyma of the kidney appeared normal grossly.

In this case no symptoms were present

relating to the cyst which was merely a coincidental finding at autopsy. The presence of a small cyst of the spleen and of the left lobe of the liver were interesting coincidental findings.

Case 2. The patient, male, aged 42 years, entered the Clinic on April 27, 1931, because of blood in the urine, the hematuria having appeared fourteen months previously. At that time he had been subjected to a cystoscopic examination elsewhere, and blood had been reported spurting from the right ureteral orifice. No definite diagnosis was made. Three months before the patient was admitted to the Clinic, a second cystoscopy had been performed by another physician, and again the diagnosis had not been determined. The hematuria had appeared intermittently and had not been accompanied by pain. Two days before admission the hematuria had reappeared and had persisted, and this time it was associated with pain in the region of the right kidney.

The patient was well nourished and well developed. His temperature was 98.6° F, the pulse rate 74, and the blood pressure 115 systolic, 75 diastolic. The right kidney was not palpable and a roentgenogram of the kidneys, ureters, and bladder showed no abnormality. The cystoscopic examination was difficult because of a small meatus. No gross bleeding was noted although the bladder urine was bloody. A Garceau catheter was passed a short distance up the right ureter. The urine collected was bloody and was sent to the laboratory for study. The pyelogram of the right kidney showed a large pelvis with a filling defect in the upper calyx which was attributed to the probable presence of pyelitis with the possibility of calculus or a tumor in the upper calyx.

The catheterized specimen of urine from the right kidney showed a few white blood cells, many red blood cells, and no tubercle bacilli. The catheterized specimen from the left kidney was normal.

The blood count showed 4,960,000 red blood cells, 97 per cent hemoglobin, and 6,400 white blood cells. The blood sugar

was 95 mgm per cent and the blood urea 27 mgm per cent. The non-protein nitrogen was 33.6. The blood Wassermann reaction was negative. Urine examination revealed a faint trace of albumin, one plus white blood cells, and three plus red blood cells.

A diagnosis of tumor of the right kidney was made and a nephrectomy performed on May 1, 1931. The patient's convalescence following this procedure was uneventful.

The right kidney weighed 155 grams and measured 11.5 × 6 × 3.5 centimeters. The capsule stripped readily and the kidney was reddish-brown in color, with remnants of fetal lobulations. There were small areas of scarring over the cortex of the kidney. In the upper pole and on the medial surface there was an elevated, thin-walled, grayish-white cystic area measuring 2 cm in diameter. The cyst contained a brownish fluid.

Longitudinal section through the kidney showed that the cortex and medulla were well differentiated. The depth of the cortex averaged 8 mm and of the medulla 15 mm, the pyramids were distinct. The upper calyx was dilated and the mucosa of the pelvis underlying the cystic area was reddened, thickened, and puckered. The remaining mucosa showed small punctiform hemorrhages and roughening of the mucosa. The gross and microscopic diagnosis was solitary cyst and chronic pyelitis of the right kidney.

This case is of interest especially from the diagnostic standpoint. The pyelogram was suggestive of a tumor of the upper pole of the kidney and a definite diagnosis was not established until nephrectomy had been performed. An additional point of interest was that this cyst contained bloody fluid in contrast to the clear fluid usually found in the solitary cysts of the kidney.

Case 3. A man, aged 50 years, came to the Clinic May 7, 1934, to seek relief from kidney colic. One year before he had experienced a sudden severe pain in the left kidney region radiating into the left

groom Three months later, he had experienced a second attack of more severe pain which again radiated to the left groin This was associated with nausea and vomiting, so severe that a hypodermic of morphine had been administered to relieve the pain One week before admission he had another attack which was not so severe as the previous ones At the time he was examined he complained of a constant aching in his left side No gross hematuria had been noted and he had never passed a stone or gravel in his urine His family physician had told him that casts and pus were present in the urine and had prescribed a low protein diet for him

The patient was well developed and nourished His temperature was 98.6° F, the pulse rate 80, and the blood pressure 125 systolic, 80 diastolic A roentgenogram of the kidneys, ureters, and bladder revealed a small stone in the pelvis of the right kidney

The cystoscope was introduced with fair ease There was no residual urine and no abnormality in the bladder Both ureters were catheterized without difficulty The specimen of urine from the left kidney contained considerable blood, while that from the right kidney was clear A bilateral pyelogram was done The right kidney appeared normal and the stone which showed on the roentgenogram was obscured by the pyelographic medium The left kidney showed a deformity of the pelvis and upper calyx It was thought that this might be produced by a tumor, probably a hypernephroma

Laboratory Data—The blood count showed 4,990,000 red blood cells, with 91 per cent hemoglobin, and 7,400 white blood cells The blood sugar was 78 mgm per cent and blood urea 48 mgm per cent The urine contained a faint trace of albumin, occasional red blood cells, and occasional white blood cells The Wassermann reaction was negative Catheterized specimen from the right kidney showed three plus red blood cells, and one plus white blood cells, from the left kidney, rare red blood cells and no white blood cells

A diagnosis of tumor of the right kidney was made and nephrectomy was performed on May 24, 1934 Convalescence was uneventful The specimen of kidney weighed 135 grams and measured 11 × 7 × 4 centimeters It contained a large cortical cyst at the upper pole of the kidney which was filled with clear, yellowish fluid

This case is of interest from the diagnostic standpoint for careful urologic studies pointed toward the presence of a renal neoplasm Another interesting factor in this case was that for a period of a year, the patient had experienced attacks of pain indicative of renal colic Not until a nephrectomy had been performed and the specimen incised could the presence of a neoplasm be excluded

(The accompanying Figures 1 to 4 show the roentgenographic findings in cases of solitary cyst of the kidney These cases illustrated are not reported in the paper)

SUMMARY AND CONCLUSIONS

1 Three additional cases of solitary cysts are added to the series previously reported (2)

2 Solitary cysts probably occur more frequently than is apparent from reports in the literature

3 A roentgenogram may reveal the presence of a cyst, especially when it attains considerable size and when a difference in density between the cyst and the renal parenchyma can be noted

4 The pyelogram may appear normal or the cyst may bulge into the renal pelvis, producing a deformity

5 Conservative operation with dissection of the cyst away from the renal parenchyma, or the removal of the cyst together with a wedge-shaped portion of the pole of the kidney is advisable

6 Nephrectomy is rarely necessary unless the cyst is associated with renal tuberculosis, calculi, or tumor

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OBSTETRICAL ROENTGENOGRAPHY

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THE demonstration of shadows of fetal bones on the roentgenogram is unquestionably the most positive sign of pregnancy that we have to-day. On the other hand, failure to demonstrate a fetus on the film does not by any means

positive diagnosis of pregnancy, the roentgen ray will determine the presence of a multiple pregnancy, the position of the fetus, abnormalities of the fetus, and even fetal death. Cases of extra-uterine pregnancy (abdominal) at term have been



Fig 1 The patient, at the time of this examination, was five months and eleven days pregnant yet no fetal bones are demonstrable. A wide separation of the sacroiliac synchondroses may be seen.



Fig 2 Same case as shown in Figure 1 taken a month later. Fetus may be plainly seen.

rule out pregnancy even as late as the fifth month, as demonstrated in one of our cases reported below. This latter condition, however, is the exception rather than the rule.

Fetal bones have been shown as early as the third month, they are commonly demonstrated by the fourth month, and should be shown with very few failures by the fifth month. In addition to the

successfully diagnosed by means of roentgenographic examinations.

The films used for the diagnosis of pregnancy should be of the best quality, the screens should be comparatively new and fast, and the patient should have a cleansing enema to rid the colon of gas and feces. Particularly is this true in the early months of pregnancy when we are confronted with the problem of de-



Fig 3 A ten-weeks pregnancy The cranial vault and spine may be seen



Fig 4 Anencephaly Note absence of cranial vault

ciding whether a patient is or is not pregnant. A Potter-Bucky diaphragm is essential. The two standard positions, anteroposterior or postero-anterior and lateral, are to be preferred in the later months. Several modifications of these positions have been recommended for the purpose of eliminating the confusing shadows produced by the sacrum and fifth lumbar vertebra.

In the last few years obstetrical roentgenology has taken a decided impetus, judging from the amount of literature on the subject. This advance has been due to the fact that we have developed instruments of precision, and also because the fear of damaging the fetus with the x-ray has been allayed to a certain extent. The obstetrician of to-day has come to realize that the x-ray in competent hands is not as dangerous a weapon as it used to be during pioneering days, and that a good many of the uncertainties with which he comes in daily contact can be made visual images for him. Our own experience has been that whenever the obstetrician has encountered a variation from the normal he has been the first to advise roentgenographic examination for his patient. Occasionally we have had patients

who insisted on having roentgenograms made, thus showing that the public is gradually being educated.

Although it is the general consensus of opinion that a fetus is demonstrable at the fifth month, one must not forget the fact that this is not always true, as exemplified in the following case.

Mrs W. H., age 31, II-para (Fig 1 and 2), was referred to my laboratory on June 26, 1933. Her physician told me that she was about five months pregnant. She had been feeling well up until two weeks previous to the examination, when she noticed a painful tumor mass in the right quadrant, gradually getting larger. Her physician wanted to know whether or not he was dealing with an extra-uterine pregnancy. The patient gave a history of an uneventful pregnancy and delivery ten years previously. She had not felt "life" and she volunteered the information that she did not see how she could be pregnant, since she and her husband had been practising birth control



Fig 5 Anteroposterior view of anencephalic monster after delivery

Fig 6 Lateral view of same anencephalic monster

with "medicines and appliances." Upon examination we found a tumor mass, round and boggy, reaching to the level of the umbilicus, and giving one the impression of a five-months pregnancy. Attached to this mass, on the right side, was another smaller, rounded, tender mass about the size of a small fist. A roentgenogram failed to reveal the presence of any fetal bones and a report was given the referring physician that "we could not detect the presence of fetal bones at this stage." The patient continued to have a great deal of discomfort and this, coupled with the negative x-ray findings, influenced the surgeon to open the abdomen although he was very reluctant to do so, and insisted that the patient was pregnant. The laparotomy revealed a pregnant uterus with a fibroid on its right lateral wall. The patient made an uneventful recovery after the myomectomy and, at my in-

sistence she came to my laboratory for another roentgenogram about a month after the first one. This time we demonstrated the fetus. She was delivered on Oct 15, 1933—the first x-ray examination had been made on June 26, 1933. In other words, she was five months, eleven days, pregnant when I first examined her and yet we could not visualize the fetus.

In contrast with the above case, we were able to demonstrate a pregnancy at about the tenth week (Fig 3) in a primipara 23 years old. Undoubtedly calcium deposition in the fetal bones is variable, some cases showing it plainly in ten weeks and others going twenty weeks and over without any demonstrable traces. It is, of course, due to this delayed calcium deposition that we have occasional failures at the fifth month.

Anencephaly—Case (1), in 1917, was the first to successfully diagnose the



Fig 7 Hydrocephalus Note the enormous size of the head

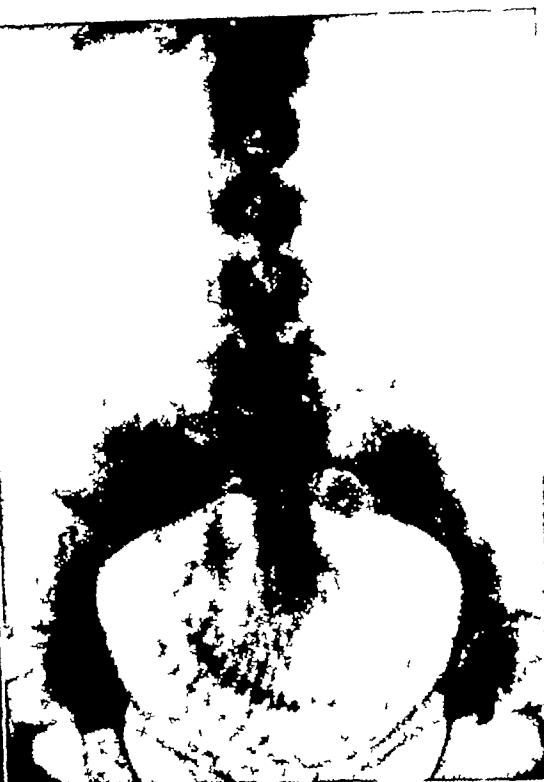


Fig 8 Neglected transverse Note the semicircle formed by the spine

presence of anencephaly before birth by means of the roentgen ray. Since then there have been only 19 more cases reported. The incidence of this condition, five in 1,621 obstetrical cases in the Battle Creek Sanitarium (2) from 1916 to 1926, leads us to believe that these cases are not being reported. Of the five cases reported by Case (2), three were diagnosed *in utero* by means of the x-ray. We have had two in the past year and both were diagnosed before delivery (Figs 4, 5, and 6).

Clinically, these cases present certain characteristics which will make the experienced and careful obstetrician suspicious of the condition. However, we must frankly admit that a suspicion is not a diagnosis. These cases, with very rare exceptions, can be successfully diagnosed long before the onset of labor and thus the expectant mother may be saved the discomfort of the last few months of

pregnancy and the mental anguish which she would experience on realizing that the child she so carefully and longingly carried for nine (perhaps "stormy") months is a monster. Now that the obstetrician may, without any added discomfort to the patient, and without any fear of injuring either the mother or the fetus, utilize the roentgen ray, it seems reasonable to invoke the aid of this valuable diagnostic means, especially in those cases in which there has been a deviation from the normal course of the pregnancy.

The roentgen findings in anencephaly are characteristic and leave little doubt as to the diagnosis. The absence of the cranial vault, which in the unborn fetus is the most conspicuous part, is pathognomonic of this monstrosity. Spina bifida, often associated with anencephaly, may at times be diagnosed correctly. Doub (3), in 1925, was the first to point

out the presence of *spina bifida* on a pre-delivery roentgenogram and since then others have demonstrated the condition in like manner

One of our cases of anencephaly (Figs 4, 5, and 6) was that of a primipara 27 years old. She was referred for x-ray examination because of an unusually large abdomen which had grown very rapidly in the previous two or three weeks. She was at the time in the eighth month of her pregnancy. Roentgenograms revealed the presence of an anencephalic monster. Her pregnancy was interrupted and she made an uneventful recovery.

Hydrocephalus—To be forewarned of the presence of hydrocephalus is undoubtedly of great help to the obstetrician. Knowing what he has to contend with, he can then decide the best method of procedure. We believe that hydrocephalus can be accurately diagnosed by the roentgen ray, provided one avails himself of several films in several positions. In this manner exaggeration of the size of the head produced by distance from the part to the film can be eliminated.

Multiple Pregnancy—Multiple pregnancy, of course, is very easily diagnosed with the roentgen ray. Films made as near delivery as possible are the best because then the obstetrician knows exactly the position and whether either fetus is likely to produce an obstruction or not.

Abnormal Positions—We have had the opportunity to examine several abnormal positions or, rather, presentations, as the patients were examined either during the first stage of labor or after being in labor for a number of hours without progress. The breech presentation is, of course, easily recognized. In the last

few months we have had occasion to x-ray two transverse positions, one of them the so-called "neglected transverse" (Fig 8).

Fetal Death—In 1922, Spalding (4), in a study of 21 fetal deaths, pointed out the fact that overlapping of the cranial bones was pathognomonic of fetal death. We believe, judging from our own observation on two cases, that when overlapping occurs the fetus has been dead for some time.

We have purposely confined ourselves in this discussion to the simpler and safer methods of radiographing the pregnant woman. Pneumoperitoneum has its field, but it really is of greater value in gynecology than in obstetrics. Our present methods of pelvimetry will have to be simplified before they become generally accepted. The injection of an opaque medium is a method which deserves much study and care, and, as we all know, is not as yet a very safe procedure.

SUMMARY

- 1 The simpler methods of obstetrical roentgenography are discussed.
- 2 A case of mistaken diagnosis is reported.
- 3 Anencephalus and hydrocephalus each are discussed and cases reported.
- 4 Fetal death, abnormal presentations, and multiple pregnancies are discussed.

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GASTROJEJUNOCOLIC FISTULA¹

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THE first case of gastrojejunocolic fistula reported in the literature was in 1903, by Czerny. Haudek was the first to report the diagnosis of gastrojejunocolic fistula by roentgen-ray study, in 1912, in a case of carcinoma of the stomach. In 1921, Loewy compiled from the literature 76 cases of gastrojejunocolic fistula, and in 1925 Verbrugge compiled 102 cases of both gastrocolic and gastrojejunocolic fistulas, adding 21 more cases collected at the Mayo Clinic. To date, 250 cases of gastrocolic and gastrojejunocolic fistulas have been reported in the literature.

Lewisohn, reviewing the gastro-enterostomy cases at Mount Sinai Hospital, New York, during the period 1915 to 1920, reported the occurrence of jejunal ulcers in 34 per cent. This percentage is considerably higher than the 5 to 10 per cent reported in the German literature, in the latter cases they were eleven times more frequent in men than in women. Verbrugge reports that at the Mayo Clinic the percentage of those having gastrojejunocolic fistula following gastrojejunal ulcer was 11.36 per cent.

Prior to the popularity of gastro-enterostomy in the treatment of gastric and duodenal ulcers, the classification of causes of gastrocolic fistula was as follows: first, cancer, second, ulcer, third, gastro-enterostomy, fourth, abscess in the peritoneal cavity, fifth, tuberculosis, and sixth, congenital anomaly. With the growing popularity of gastro-enterostomy it was noted that the fistulas due to carcinoma were decreasing and that those due to ulcer were increasing.

Pathology—The pathology is first that

of a duodenal ulcer, then, following a gastro-enterostomy, an ulcer develops at the stoma and spreads around the jejunum. The ulcer becomes plastered to the colon, later perforates to form the gastrojejunocolic fistula.

Symptoms—The four cardinal symptoms of gastrojejunocolic fistula are: (1) diarrhea (in a patient with a history of an operative procedure for ulcer), which is persistent with soft, yellowish or grayish stools containing undigested food and fat, (2) fecal vomiting, without intestinal obstruction, (3), loss of weight, and (4), eructation of fecal smelling gases.

Signs—An important sign is the visualization of the fistula by roentgen-ray examination with an opaque enema. In this way a diagnosis has often been made when the condition was not even suspected clinically. Some cases have a fistula with a valve-like formation at the site of communication, so that a contrast meal may not show the condition while a barium enema readily discloses it (Groeschel), or the fistula may be seen at certain examinations and not at others (Haudek). Then, again, some observers have used enemas of methylene blue or carmine and have recovered the dye from the stomach by lavage in from one-half to one hour following the injection of the dye *per rectum*.

CASE REPORTS

Case 1. Male, age 40, white, by occupation a farmer. The *family history* is essentially negative. The *personal history* is as follows. Patient had the usual childhood diseases. At the age of 13 he had an appendectomy. His general health was good up to his period of war service, when he was hospitalized at Bordeaux, France, for stomach trouble in May, 1919. His

¹ Published by the authority of Dr. Charles M. Griffith, Medical Director, Veterans' Administration, Washington, D. C.

complaint at that time was suggestive of a duodenal ulcer, for which medical treatment was instituted. After his return from service, he was operated on in July, 1919, for a "subacute, perforating ulcer on the anterior and inferior wall of the duodenum just below the pylorus" (operative report). The operation consisted of cauterization of the ulcer and a gastro-enterostomy. The patient returned to his occupation approximately one year after the operation and remained in good health until June, 1929, when he complained of periods of diarrhea. These lasted approximately six to eight weeks, followed by a symptom-free interval for as long as six months. Recurrence of these attacks of diarrhea occurred until the patient reported to this hospital for examination in April, 1931.

Chief Complaints—Upon admission he stated that he had been troubled with frequent bowel movements, numbering from four to six daily, with the present attack of diarrhea of one week's duration. The stools were soft and no blood was noted. These attacks of diarrhea have been associated with a generalized weakness and the patient believes that he has lost approximately fifteen pounds in weight.

Physical Examination—Reveals a white male, not acutely ill, fairly well nourished and weighing 150 pounds (normal weight ranges from 165 to 168). The clinical examination was negative with the following exceptions. The breath had a somewhat fetid odor. Blood pressure was 118/82 and the pulse 88. The abdomen revealed a scar to the right of the midline, extending upward from the level of the umbilicus for about five inches, and another scar three inches in length in the right lower quadrant. The abdomen was soft and tender to deep palpation.

Laboratory Examinations—Urinalysis was essentially negative, blood Wassermann and Kahn tests were negative, hemoglobin, 94 per cent, red blood cells, 5,080,000, white blood cells, 13,700, feces

were negative for amoeba in two examinations.

Radiologic Examination—Fluoroscopic examination of the esophagus is negative. The stomach reveals the presence of a gastro-enterostomy, and a fairly rapid emptying of the gastric contents into the small bowel. None of the contrast meal can be seen passing through the pylorus. At the sixth hour the greater portion of the meal is within the small bowel and the head of the meal is just entering the cecum, gas is prominent throughout the colon. At the twenty-four-hour examination the cecum and ascending colon are empty, and spastic changes are noted throughout the remainder of the colon. At the forty-eight-hour examination only scattered areas of the opaque medium are seen throughout the transverse and descending colons.

Radiologic Diagnosis—Fairly well-functioning gastro-enterostomy and spastic changes in the colon.

The patient was placed upon a dietary regimen and medical treatment was instituted, the latter consisting of enemas of neutral acriflavine. This treatment afforded some relief for approximately one month but at the end of that time the symptom-complex of recurrent diarrhea again returned. The patient was then referred for further radiologic observation.

Second Radiologic Examination (May, 1931)—Examination of the colon by means of a barium enema revealed no obstruction to the inflow of the opaque medium. The descending colon in its distal portion filled poorly. The enema reached the last half of the transverse colon, where a portion of the opaque medium was seen to enter the small bowel, while the remainder of the enema passed readily to fill the first half of the transverse colon and ascending colon. Pressure upon the abdominal wall, by the examiner, over the last third of the transverse colon forced the opaque medium farther into the small bowel (no discomfort was experienced by the patient). Continued pressure upon the transverse colon forced more of the

opaque medium into the small bowel and then into the stomach, where it reached the upper portion of the cardia (Fig 1)

Recheck gastro-intestinal series revealed a large stomach in normal position and the presence of a fairly well-functioning gastro-enterostomy. None of the contrast meal was noted as passing through the pylorus. Thirty minutes after the ingestion of the meal there was a 10 per cent gastric retention and the remainder of the meal was visualized throughout the small bowel. At the sixth hour there was some ileal retention and the remainder of the meal was noted in the ascending colon. At the twenty-fourth hour the entire colon was spastic.

Radiologic Diagnosis—Gastrojejunal fistula with valve present between the large and small bowel, and spastic changes in the colon.

The patient was transferred to the surgical service where he refused operation and was discharged from the hospital upon his own request.

Case 2 Male, age 40, white, by occupation a painter. The *family history* is essentially negative. The *personal history* is as follows: Patient had the usual childhood diseases. History of gonorrhea in 1911, and in the same year (at age of 21) he was operated upon for a ruptured gastric ulcer. His general health then remained good with no history of hospitalization until January, 1927. He had no disability during World War service. He admitted syphilitic infection immediately after discharge from military service, two courses of anti-syphilitic treatment were completed in 1919. The first radiologic diagnosis of duodenal ulcer was made in January, 1927. From January, 1927, until July, 1932, there is a history of seven admissions to the hospital for medical treatment of a duodenal ulcer, and as patient refused surgical intervention, medical treatment was carried out throughout these years. In July, 1932, symptoms became so severe that the patient consented to an operation.

Chief Complaints—Upon admission to



Fig 1 Barium enema described in Case 1, showing the colon fistula and the partially outlined stomach. Arrows indicate fistula.

the hospital in July, 1932, the patient stated he had pain over the entire abdomen but more localized in and around the umbilicus. This attack of acute pain had been present for the past three weeks, and was associated with nausea, coming on acutely from one to one and one-half hours following the ingestion of food. The intake of food or alkalis rendered some relief to the pain. Vomiting was frequent but no blood had been noted in the vomitus. No tarry stools were noticed. Generalized weakness has been present for the past three months.

Physical Examination—Reveals a poorly nourished white male, acutely ill and confined to bed. The clinical examination was negative with the following exceptions. The tongue is slightly coated. The lungs reveal a few scattered râles heard over either base. The heart sounds are weak and indistinct but no murmurs are heard. Blood pressure is 115/75. The abdomen reveals a right rectus scar

and is tender throughout to ordinary palpation, though more marked in the epigastrium and upper left quadrant. Left rectus muscle spasm is present. The muscles are flabby. The genitalia reveal an old scar on the glans penis and a left varicocele. The reflexes are equal and hyperactive.

Laboratory Examinations—Urine has a specific gravity of 1.025, faint trace of albumin, occasional hyaline casts, 8 to 10 leukocytes per high power field and occasional red blood cell. The stool was yellowish-brown in color and fairly well formed, negative for blood. The fractional gastric analysis was as follows:

Time	Amount	Free HCl	Total Acidity	Lactic Acid	Bile	Blood
Residuum	30 c.c.	40°	52°	Neg	Neg	Trace
9 00	18 c.c.	46°	60°	Neg	Neg	Trace
9 15	20 c.c.	78°	98°	Neg	Neg	Trace
9 30	16 c.c.	76°	102°	Neg	Neg	Trace
9 45	20 c.c.	80°	104°	Neg	Neg	Trace

Blood analysis showed red blood cells, 4,140,000, white blood cells, 10,600, polymorphonuclears, 62 per cent, small mononuclears, 28 per cent, large mononuclears, 5 per cent, transitionals, 3 per cent, eosinophils, 1 per cent, basophiles, 1 per cent. Wassermann and Kahn tests were negative. Ten sputum examinations were negative for tubercle bacilli.

Radiologic Examination—Fluoroscopic examination of the esophagus was negative. The stomach was low in the abdomen, with the greater curvature three finger-breadths below the brim of the pelvis. No pathology was noted involving the gastric contour. The duodenal bulb revealed a constant filling defect on the lateral aspect. At the sixth hour, there was approximately a 30 per cent gastric retention, and the remainder of the meal was in the transverse colon which was low on the pelvic floor. At the twenty-fourth hour, the colon was empty.

Radiologic Diagnosis—Duodenal ulcer with partial obstruction.

Surgical intervention was allowed on July 21, 1932, and the operative findings

were "a large indurated mass, the size of a lemon, distal to the pyloric ring and adhered densely to the pancreas and gall bladder." A posterior gastrojejunostomy was performed, and the patient went on to uneventful recovery, being discharged from the hospital on Aug. 24, 1932.

He continued in fairly good health for several months until he again reported for surgical consultation on Feb. 6, 1933. *Consultant's Report*—"Considerable pain is evident in epigastrium. The patient has a large perforating ulcer which was noted at previous examination and as no appreciable amount of relief from pain was obtained following gastro-enterostomy and in view of considerable pain, high acidity, etc., gastric resection is advisable for gastrojejunal ulcer." The patient refused surgical intervention at this time.

Radiologic examination dated April 5, 1933, revealed the stomach of normal size and position with no evidence of any gastro-enterostomy stoma being noted. Some of the meal was forced through the pylorus. The duodenal bulb was ragged but no filling defect was apparent. At the sixth hour there was a small amount of gastric retention, apparently in the region of the site of the gastro-enterostomy. The remainder of the contrast meal was noted in the terminal ileum and scattered areas of the meal were seen in the colon. The radiologic diagnosis at this time was gastrojejunal ulcer.

The patient again presented himself for hospitalization on Aug. 3, 1933, with the diagnosis of acute intestinal obstruction. The operative findings at this time were "numerous adhesions around small intestine, adhesions of the hepatic flexure to the anterior abdominal wall, large ulcer mass involving duodenum and gastrojejunal junction with perforation into the colon at the site of anastomosis." The adhesions were liberated, and as the mass was too large to resect and too much inflammatory tissue was present, a jejunostomy was performed and the wound closed. Five hours later the patient was

given a transfusion of 500 cc of whole blood, by the indirect citrate method. The surgical diagnosis was perforating duodenal gastrojejunal ulcer with gastrojejunocolic fistula.

The patient made a fairly good recovery and further radiologic study was carried out on Dec 9, 1933. At this time a fluoroscopic examination of the colon revealed some dilatation of the rectum and sigmoid but no obstruction was noted to the inflow of the opaque medium which readily reached the region of the cecum. Adhesions were noted near the mid-point of the transverse colon but no evidence of any fistula could be demonstrated.

Radiologic examination of the colon dated Jan 25, 1934, revealed no obstruction to the inflow of the opaque medium. No evidence of any intrinsic pathology was apparent. Some evidence of adhesions was noted involving the mid-portion of the transverse colon but no evidence of any gastrocolic fistula was demonstrated.

The patient was referred to the surgical service for further examination as to the advisability of gastric resection, as recommended in February, 1933.

Surgical Consultation Report (Feb 13, 1934)—"Complains of pain in back coming on frequently, associated with pain in epigastrium, present in severe degree. Usually more severe at night after meals and usually when bowels are not active. No vomiting at the present time. The present examination reveals extreme tenderness in the epigastrium. The patient has a large perforating mass near the gastro-enterostomy site and the first portion of the duodenum. Further x-ray study is indicated which study patient refuses. Gastric resection is indicated, and as patient refuses he should be carried on medical treatment until permission for surgical intervention is obtained or severity of symptoms will force patient to have surgical intervention."

Patient refused further surgical intervention and will continue on medical treatment.

SUMMARY

Two cases of gastrojejunocolic fistula are presented in detail, with a short review of the literature.

The first case is of the type described in the literature by Groeschel in which there is noted a valve-like formation at the site of communication of the large and small bowel. This communication was not seen during the examination with the contrast meal but was noted when a barium enema was given, thus showing the presence of the valve at the fistulous opening. In the second case the findings were noted at the operating table and only the end-result (adhesions) was seen in the transverse colon during the fluoroscopic examination of the colon at the time of the barium enema.

One should suspect a fistula in the presence of a persistent diarrhea following an operation for a gastric or duodenal ulcer, associated with symptoms of loss of weight, fecal vomiting without intestinal obstruction, eructation of fecal smelling gases, and visualization of the fistula by roentgen-ray examination or the recovery of dye from the stomach by lavage after the injection of the dye *per rectum*.

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PRENATAL DIAGNOSIS OF LACUNA SKULL

(LÜCKENSCHÄDEL)

By ROE J MAIER, B A, M D, *St Bernard's and Evangelical Hospitals, Chicago*

THE birth of a monstrosity of some one of the different types is not an uncommon occurrence, but the diagnosis of its existence before birth is far from as common as it should be. Recently H Dabney Kerr, (1) reviewed the literature on anomalies of the skull in the newborn, with special reference to "Relief" or "Lacuna Skull" (*Luckenschadel*), and presented three new cases. Still more recently Doub and Danzer (2) have reported two more cases, also in the newborn. The author has been unable to find in the literature any record of the diagnosis of this condition before delivery. In the two cases here reported the diagnosis was made during the eighth or at the beginning of the ninth month of pregnancy. This diagnosis can and should be made before delivery in every case in which x-ray examination is available.

The theories concerning the etiology have been so well reported by Kerr and Doub and Danzer that I shall only enumerate them here.

1 Wieland (3) —Ossification cannot keep pace with the rapid growth of the brain during the latter months of pregnancy.

2 Cohn (4) —It is the result of failure to pass a normal phylogenetic stage of development at this particular period.

3 Kassowitz (5) —It is the result of abnormal pressure on the vertex during delivery.

4 Wieland and Faust (6) —It is the result of increased intracranial pressure.

5 Kato (7) and Engstler (8) —It is the result of maldevelopment *per se*.

The theory of Wieland and Faust is supported by the finding of encephalocele, meningocele, spina bifida and other malformations in a very large percentage of



Fig 1 Case 1 About 8 months pregnancy microcephaly lacuna skull and spina bifida

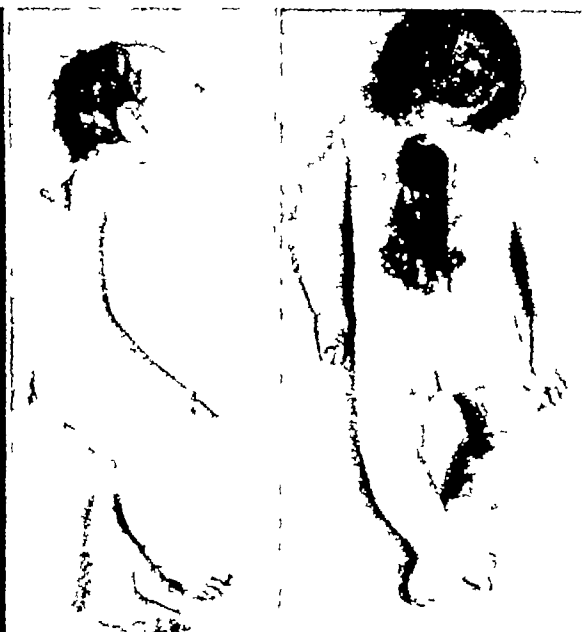


Fig 2 Case 1 The fetus delivered, showing microcephaly and meningocele

MONROE R T and EMERY, E S JR Gastrocolic
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the heart tones had still been audible the previous day. The fetus had a typical microcephalic head with the following

Case 2 June 25, 1934, Mrs J D was referred to the x-ray department of St Bernard's Hospital for roentgen pelvim-



Fig 5 Case 2 Eight-months pregnancy "Lacuna skull" and abnormal curvature of spine indicating spina bifida



Fig 6 Case 2 Photograph of fetus showing meningocele

measurements Occipito-frontal, 8.1 cm as compared with full term average measurement of 11.5 cm, bi-parietal, 7.7 cm as compared with full term average of 9.5 cm, perimeter was 26.5 cm as compared with full term of 35 cm. There was evidence of an extensive spina bifida with protrusion of the meninges of the cord. X-ray examination showed the absence of sutures and fontanelles nearly closed, extensive convolutional atrophy, and the typical disproportion between the size of the cranium and facial bones. Several of the cervical and upper dorsal vertebrae were fused, with an extensive spina bifida involving the cervical and dorsal vertebrae. There was also an abnormal development of the first to sixth ribs on the right side. Postmortem examination was refused. The mother had an uneventful convalescence and was discharged December 8.

etry. She was a primipara, 33 years of age, white, married twelve years. The last menstrual period had been Nov 2, 1933. Wassermann, Kahn, and urine tests were negative. Previous menstrual and family history negative, no previous pregnancies or abortions. The patient had osteomyelitis when a child.

The results of roentgen pelvimetry showed normal pelvic measurements. The films showed a skull smaller than normal, however, with many lacunae with dense ribs between and an abnormal curvature of the vertebrae in the lumbar region. From these findings a diagnosis of lacuna skull with spina bifida was made and a poor prognosis for the life of the fetus given.

The patient returned to the hospital for delivery July 9, 1934, and was delivered of a fetus weighing five pounds, three ounces. The skull measurements

these cases In true relief skull, no cases have been found without an accompanying meningocele or encephalocele

because of a moderate polyhydramnios such as often indicates the presence of some type of monster The patient was a



Fig 3 Case 1 Roentgenogram of fetus showing lacuna skull and spina bifida



Fig 4 Case 1 Roentgenogram of fetus showing lacuna skull, spina bifida and deformity of upper six ribs on right side

X-ray Appearance—In any film of a pregnancy showing the skull of the fetus the lacunæ or the irregular ossification of the skull is readily visible, and the lateral view of the fetal vertebral column shows an abnormal curvature at the point of the spina bifida and meningocele This typical appearance is very apparent in the accompanying illustrations

CASE REPORTS

Case 1 Nov 14, 1933, Mrs J M was referred to the X-ray department of Evangelical Hospital for roentgen examination

white, American woman, aged 25, primipara According to her menstrual history she was early in the eighth month of pregnancy Urine and Wassermann tests were negative The films revealed irregular ossification of the skull, with markedly decreased bi-parietal and occipito-frontal measurements and an abnormal curvature of the spine From these films a diagnosis of microcephaly, with irregular ossification of the skull, and spina bifida, was made

On November 26, twelve days later, labor started and a four-pound, twelve-ounce dead fetus was delivered, although

Lückenschädel are distinctly and readily visible on x-ray examination during the latter months of pregnancy and should present little or no difficulty in diagnosis

CONCLUSIONS

1 Two cases of *Lückenschädel* diagnosed before birth are reported

2 *Lückenschädel* can and should be diagnosed as early as the eighth month of pregnancy

3 Early diagnosis may be of great advantage to the obstetrician in determining his subsequent treatment and procedure

The author wishes to thank Dr H Mackoff and Dr J A Parker for permission to report these two cases

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at birth were Occipito-frontal, 10 cm , bi-parietal, 8.8 cm , with a perimeter of 28.5 cm . There was an accompanying

COMMENT

While the cranial measurements in these

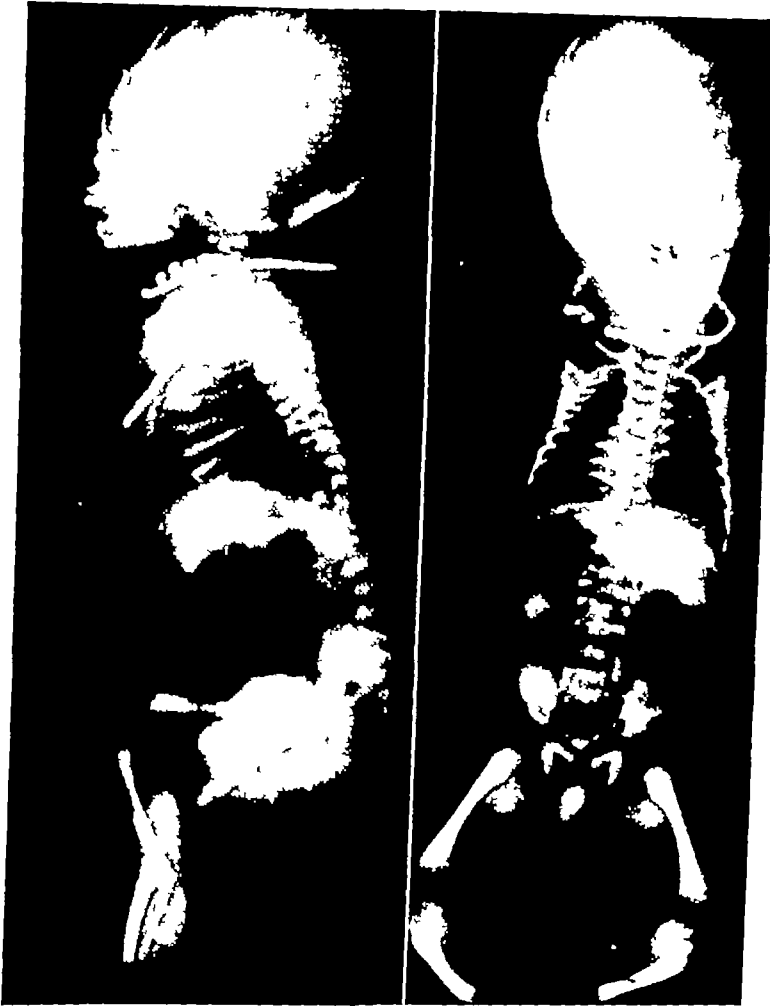


Fig 7 Case 2 Roentgenogram of fetus showing lacuna skull and spina bifida

Fig 8 Case 2 Roentgenogram of fetus showing lacuna skull and spina bifida

spina bifida in the lumbar region . The baby expired July 20, 1934, living eleven days . X-ray examination of the fetus after birth showed the typical lacuna skull, with spina bifida involving the lumbar vertebrae and sacrum . Postmortem examination refused . The mother had an uneventful convalescence and was discharged July 22, 1934 .

two cases are below normal, the first even classed as a microcephalic, the lacunæ and dense bony ribs separating them are so evident and are accompanied in both cases by spina bifida and meningocele, that the author believes both of these cases should be classed as lacuna skull or *Luckenschädel* . These two cases demonstrate that the abnormalities found in

(3) The high tension wires are readily attached by lowering the mounted device, until the tube is within easy reach

(4) The apparatus, when properly adjusted for an exposure, is practically shock-proof, due to the great distance of the high tension wires from the patient

(5) Stereoscopic views are readily made by shifting the tube stand, together with the device mounted upon the cross-arms, along the cephalo-caudad axis of the body. Since a 6-inch stereo-shift is proper for a six-foot focal-film distance, it is advisable to tilt the tube so as to effectively cover the desired area.

(6) In radiographing the chest of a patient in the semi-erect position in bed, the tube stand is accordingly tilted to the desired angle, to be determined by the position of the patient propped up in bed.

(7) Any desired focal-film distance is accurately procurable by adding the extended height of the device to the distances upon the calibrated vertical tube stand rod.

(8) An exceedingly useful procedure in chest radiography, when it is deemed inadvisable to move the patient from the bed to the roentgenographic table, consists in swinging the mounted device upon the tube stand outward away from the examining table. The apparatus is then accurately focussed over the chest of the patient lying in the bed which has been placed alongside the radiographic table.

(9) A useful adjunct in centering the tube over the chest of the patient is the adoption of a glass filter which permits of a localizing beam of light, and with a small circular piece of black paper pasted upon the center of the glass filter, the exact center of the beam is determinable upon the object to be radiographed. It is, of course, necessary to slightly darken the radiographic room. Two thicknesses of ordinary sheet window glass serve admirably for a filter with the equivalent filtration value of 2 mm of aluminum.

Sacro-iliac Articulation—The method of detecting and measuring the degree of rotatory motion of the sacro-iliac articulation, as advocated by Chamberlain,¹ has met with favor by many radiologists, especially in the roentgenographic demonstration of the formerly questioned entity of sacro-iliac relaxation. Briefly, the method consists in having the patient bear the entire weight of the body first upon the right lower extremity and then upon the left lower extremity, while he stands facing a vertical Potter-Bucky diaphragm. Utilizing a radiographic cone, two postero-

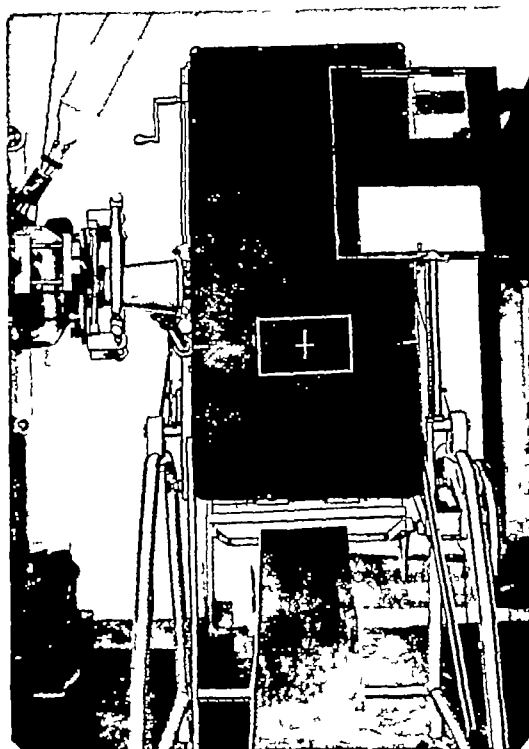


Fig. 2 Genito urinary radiographic table in vertical position showing 5 X 8 inch scribed central area. The inclined plane is placed beneath the apparatus. Note the device for shielding one-half of the 8 X 10 inch cassette (placed in the upper right-hand corner of the apparatus) showing protective sheet lead in front and sheet metal back mounted upon a wooden frame having a metal bar at the upper end which facilitates its removal from the grid tray.

anterior projections of the symphysis pubis are obtained, each exposure being carefully marked with R and L lead markers, respectively.

The normal degree of motion of the sacro-iliac articulation as reflected and magnified in the amphiarthrodial articulation of the symphysis pubis is from 0 to 0.5 mm in the male and from 0 to 1.5 mm in the non-pregnant female. During pregnancy there is a normal increase in amplitude of motion of both the sacro-iliac and symphysis pubis articulations. It has been found by various reliable observers that the symptoms of sacro-iliac relaxation are almost invariably referred to the side of the high pelvis as seen in the symphysis pubis.

Thus for a complete study of sacro-iliac complaint, five views are desirable. A stereoscopic pair of the entire pelvis with the patient in the dorsal decubitus, one lateral view of the lumbo-sacral junction, and two views of the symphysis pubis employing the technique outlined above. Since many radiologic labora-

¹ The Symphysis Pubis in the Roentgen Examination of the Sacro-iliac Joint W. E. Chamberlain. *Am Jour Roentgenol and Rad Ther* 1930 24, 621-625.

CASE REPORTS AND NEW DEVICES

ROENTGENOLOGIC SUGGESTIONS

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Chest Roentgenography—The roentgenologist is frequently confronted with the troublesome problem of obtaining satisfactory roentgenograms of the chest, in a patient who is manifestly too ill to stand up or even be seated upon the edge of the bed in front of the cassette changer. Prior to the development of the device to be described, the alternatives were,

either a portable bedside roentgenographic examination, or the utilization of an unsatisfactory, relatively short focal-film distance in the roentgenographic room, allowing the patient to lie in bed. Since it is almost *sine qua non* to employ a long focal-film distance, in order to minimize the degree of magnified distortion, the following ingenious device has been designed to enable the operator to employ a six-foot focal-film distance, with the patient lying recumbent in bed. Furthermore, stereoscopic or single films can be made with this device.

The essentials of the apparatus as illustrated in Figure 1 can be concisely described, as follows. A tube holder taken from an old unused tube stand is fastened upon the apex of a substantially constructed stand, the base of which is attached upon the parallel arms of the tube stand of the roentgenographic table. The target of the tube mounted in the device is placed exactly three feet or two feet above the target of the tube in the original tube stand of the roentgenographic table, depending on whether the original maximum focal-film distance is three feet or four feet. Since the mean distance between the parallel supporting bars of the original tube stand is 12 inches, one can compute the spread of the beam of γ -radiation. Thus, when employing a six-foot focal-film distance with the extension device equal to three feet, there is a 24-inch spread permitted in the caudad-cephalad dimension of the chest, and a 36-inch spread if a two-foot extension upon an original four-foot focal-film distance is used. It is apparent that this allows ample unobstructed γ -radiation to properly cover a 14 \times 17 chest film, even when employing a 6-inch stereo-shift.

The numerous advantages of radiography of the chest, when employing this device, are enumerated as follows:

(1) The original tube in the radiographic tube stand can be used, if desired. For this work, it is preferable, although unnecessary, to use the modern metallic discharging chamber type of tube, inasmuch as the considerable additional and excessive weight is reduced by eliminating the heavy leaded glass protective bowl, and yet preventing a considerable amount of stray γ -radiation.

(2) The device can be easily and rapidly adjusted and removed from the standard tube stand arms, and yet securely mounted. The original tube stand is pushed out of the way toward the vertical supporting bar.

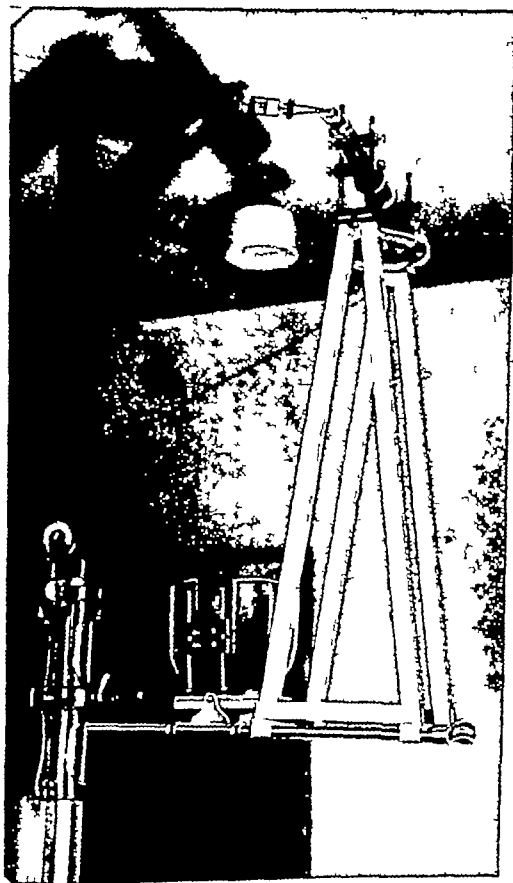


Fig 1 Showing device mounted upon the stand and cross arms swung out away from radiographic table to allow the bed to be wheeled alongside the table beneath the tube. Note the wooden rod with hook over high tension wire to anode which prevents spark jumping to near by high tension tubular conductor. Also note lead diaphragm and glass filter beneath tube stand of the device. The entire weight of the attachment is approximately four pounds. Base of device is firmly fastened to the cross-arms of tube stand by means of hook and eyes which are attached to the lower four corners of the device.



Fig 1 Postero-anterior view of the chest in Case 1. Note the pneumothorax on the left and the almost complete collapse of the lung. A fluid level is clearly seen.



Fig 2 Lateral view of chest in Case 1. The pneumothorax is plainly seen. The posterior sulcus is obliterated by the fluid present.

skin is sallow, dry, and inelastic. Muscle tone is much diminished. The eyes are sunken and glassy. The abdomen is concave. Typical signs of bilateral bronchopneumonia are elicited on percussion and auscultation. The findings are more marked on the right.

Progress—On the day of admission 200 cc of the father's blood were injected into the jugular vein and peritoneal cavity. Gradual slight improvement was noted until March 7, 1930, when another 200 cc of blood was given intraperitoneally. There was a favorable reaction until March 20, 1930, when the child suddenly became much worse. The temperature rose and the pulse was rapid and feeble, and there was moderate cyanosis. X-ray examination of the chest (Fig 3) showed a right-sided pneumothorax, with collapse of the lung. On March 22, 1930, the pleural cavity was entered with a needle under fluoroscopic control and air was withdrawn until negative pressure was obtained. The next day there was marked improvement but on

fluoroscopic examination the lung appeared to be collapsed. Air was again aspirated until the lung re-expanded. The following day there was continued improvement but the pneumothorax had returned. Aspiration was again employed but only part of the air was removed in the hope that the communication would remain closed. This was again followed by improvement but the lung appeared collapsed the next day. On April 4, part of the air was again aspirated. Improvement followed and x-ray studies four days later (Fig 2) showed the lung completely expanded. The child was discharged from the hospital three days later in good condition.

COMMENT

Spontaneous pneumothorax in infants may be divided into the following etiologic groups:

- (1) Congenital, (2) Mechanical, (3) Traumatic, (4) Infectious

tories do not possess a vertical Potter-Bucky diaphragm, but do have a genito-urinary table in which the grid is an integral part of the apparatus, the following method of procedure can be followed. The patient is elevated or lowered by means of the inclined plane as demonstrated in Figure 2, until the symphysis pubis is positioned exactly upon the scribed area. Since the grid accommodates only a 14×17 -inch cassette, the accessory contrivance also illustrated in Figure 2 was constructed, which essentially consists of an outer frame made the exact size of a 14×17 -inch cassette. In this an opening is made to accommodate an 8×10 -inch cassette. A back of sheet metal is fastened in place, and sheet lead one-sixteenth of an inch in thickness is fastened on the lower front aspect to shield the one-half of the cassette which is inserted beneath it, thus permitting the unshielded half of the film to be in the center of the grid. In this manner, a film area of 5×8 inches is also scribed on the surface of the table, to conform to the above. The technic then merely consists in making the first exposure and withdrawing the device, and inverting and reinserting the 8×10 -inch cassette to make the second exposure. The final result is that two exposures of the symphysis pubis are made upon one 8×10 -inch film, each respective view marked R and L.

SPONTANEOUS PNEUMOTHORAX IN THE NEWBORN¹

By MILTON J GEYMAN M D and DANIEL
M CLARK M D *Santa Barbara California*

Spontaneous pneumothorax is not commonly seen in children. Scott (4), in a review of the literature in 1929, collected 177 cases in children of various ages. The rarity of the condition during the first year of life, however, is indicated by the fact that Rogatz and Rosenberg (1) could find only 12 recorded cases up to 1931. Since that time about ten more have been reported. The following two cases have come to our attention during the past year.

Case 1 Baby N, white, male, age 4 weeks, admitted to St. Francis Hospital June 24, 1933, on the service of Dr. W. E. Johnson.

Present Complaint—Cyanosis and difficult, rapid breathing.

Past History—The infant had a normal delivery. Respiration began without difficulty and apparently was entirely normal. After the customary two weeks' period the child was removed from the hospital in excellent condition.

Present Illness—For the past four or five days the patient has had a "cold." On the day of admittance the child suddenly became cyanotic and there was marked respiratory difficulty.

Physical Examination—The infant is well developed and well nourished. The rectal temperature is 98 and the pulse is 82. Respiration is shallow, rapid, and at times gasping in character. There is a generalized cyanosis, particularly marked around the face and mouth. Expansion of the chest is limited. The percussion note is normal on the right, hyper-resonant on the left. The heart and mediastinum are slightly displaced to the right. Breath sounds are absent on the left. X-ray examination of the chest (Figs. 1 and 2) shows a pneumothorax on the left, with partial collapse of the lung. The visceral pleura is greatly thickened. There is a small amount of free fluid in the left costophrenic angle. The white blood count is 47,500 of which 80 per cent are polymorphonuclears.

Oxygen was administered at intervals but the cyanosis and dyspnea became increasingly worse. The child expired the following day.

Autopsy—The left pleural cavity contains many adhesions. There is an air-containing space of $5 \times 4 \times 1$ cm in size. The pleura is heavy and greatly thickened (1 to 2 mm). No communication with the bronchi is seen. There is a small amount of free pus in the left pleural cavity. The left lung is collapsed and contains no air. The cut surface is a slight beef red, with numerous thick white striae running through it. The right lung has many slightly depressed, non-crepitant areas which extend down into the tissue in a sort of wedge shape. Diagnosis: Bronchopneumonia, pyopneumothorax.

The following case is reported through the courtesy of Dr. J. M. Hayek, of Cedar Rapids, the attending physician, who has placed it at our disposal.

Case 2 Baby C, male, white, age 7 months.

Present Complaint—Respiratory infection following measles.

Family History—Negative, three brothers are living and well.

Past History—Uneventful until two weeks ago when the child contracted measles.

Present Complaint—Physician was first called on Feb. 16, 1930, and found a child with acute bronchitis and recovering from measles. Two days later physical examination indicated an early bronchopneumonia. The condition grew worse until the day of admission (Feb. 21, 1930).

Physical Examination—The patient is in a semi-stuporous and very toxic condition. The

¹ Accepted for publication July 28, 1934.

sis is a prominent feature and is most marked about the face and mouth

The roentgen diagnosis is obvious but the condition must be differentiated from eventration of the diaphragm, diaphragmatic hernia, and congenital absence of the diaphragm

Treatment is directed toward relief of respiratory embarrassment and control of infection, when present Administration of oxygen is a valuable sustaining measure When the amount of air is sufficient to threaten respiratory failure, aspiration should be resorted to Withdrawal of air usually results in temporary symptomatic relief and, in a few instances, such as in Case 2, has apparently been responsible for ultimate cure

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1520 Chapala Street

AN EFFICIENT AID IN THE PROCESSING OF X-RAY FILMS DURING THE WARM WEATHER¹

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One of the great problems of an x-ray laboratory is the proper processing of films during the warm months if the available supply of tap water exceeds in temperature the safe working limit

Much has been written relative to this important problem and many methods of water temperature control have been suggested All of these methods depend on the installation of some form of an elaborate electrical refrigeration plant, costing from \$350 to \$500 or more, which would require an extra room in which to house it The expense of installation depends on the type of cooling unit employed and the amount of work to be done If

properly installed according to the accepted methods, these motor driven compressors, with the necessary pre-cooling tanks and mixing valves, are undoubtedly the solution of the temperature control problem for the larger hospital or very busy laboratory if the expense of installation is not a great factor and if extra space close to the dark room is available Properly insulated tanks are required and the whole outfit must be large enough to deliver a sufficient amount of cooled wash water, thereby reducing the temperature a definite number of degrees, depending on the local conditions which enter into the problem of the individual laboratory

In smaller laboratories where the volume of work does not warrant the expense connected with an electrically operated cooling plant, and in those laboratories located in office buildings with high rent and without extra available space outside of the dark room in which such equipment may be conveniently installed, some other method of water temperature control must be devised

Even if the dark room happens to be large enough to accommodate a small motor driven compressor and storage tank, such installation would be impractical because of the heat which is generated and diffused by the cooling unit. The writer tried such an experiment several years ago and learned that it is not possible to extract a given number of heat units from warm tap water without having this same amount of heat diffused somewhere into the surrounding atmosphere by radiation

Each individual laboratory has its problem of water cooling After experimenting with numerous more elaborate and costly methods which were far from satisfactory, the writer has successfully developed an inexpensive and simple method of washing films during the warm months

Our problem probably differs in few respects from that of many laboratories in different parts of the country We are located in a fourteen-story office building and during the period from May 1 to November 1 the available "cold" water supply varies in temperature from 80 to 85 degrees F during the winter months the water temperature ranges from 68 to 72 degrees Fahrenheit This high temperature during the warm months is due to a natural increase in temperature of the city water supply and also to the fact that in the building the "cold" water pipes parallel the line carrying the hot water supply Using a standard "Impermo" developing tank, with compartments for the developing and fixing baths and the usual connections for hot and cold water which overflows into the waste through the stand pipe, it is of course impos-

¹ Accepted for publication June 20 1934



Fig 3 Postero-anterior view of chest in Case 2. The right lung is completely collapsed and there is a marked shift of the heart and mediastinum to the opposite side. The absence of fluid is a favorable sign.



Fig 4 Case 2 Postero-anterior view of chest after re-expansion of the lung.

Congenital pneumothorax implies an anomaly or defect present during intra-uterine life or at the time of birth, and authentic records of such cases are exceedingly rare. In one case reported by Weiner (6) autopsy showed a communication between a branch of the upper part of the left main bronchus and the pleural cavity—probably a congenital anomaly. When Stein (5) reviewed the subject in 1930 he found four recorded cases which might have been of congenital origin, and added one of his own. He regarded a history of cyanosis or dyspnea present from the onset of respiration as presumptive evidence of congenital etiology. This premise is untenable in view of the lack of autopsy evidence of congenital defect in any of the cases cited.

The mechanical group results from a combination of the muscular effort of respiration and crying with some form of obstruction to the bronchial passages. These cases usually occur shortly after the onset of respiration. Ruge (2) mentioned aspiration of meconium and

vernix caseosa as a possible cause of obstruction. Scheltema (3) suggested collapse of the epiglottis in his case.

Trauma incident to difficult delivery may occasionally be responsible for pneumothorax. The usual sequence is pleural puncture by a sharp fragment of a broken rib or clavicle. Direct injury to the lung has been mentioned as a possibility.

Infection in one form or another is the underlying cause in most cases of spontaneous pneumothorax in infants, pneumonia and tuberculosis being the most frequently mentioned forms, but whooping cough, measles, and scarlet fever may be predisposing factors. In this group, escape of air may result from rupture of a small subpleural abscess or from a localized emphysema. Most of such cases develop empyema, which is a grave complication.

The physical signs are similar to those noted in pneumothorax in the adult but less pronounced. The onset is accompanied by prostration and rapid, difficult breathing. Cyano-

able lengths of common three-quarter-inch garden hose. By actual test this pump, driven by a one-quarter horse power motor connected direct and turning at 1,720 revolutions per minute, will circulate 300 gallons of water per hour through the wash compartment of the tank. This is of course more water per minute than would be used if the films were being washed with water from the supply line.

Theoretically it does not sound reasonable to wash films in water which is being used over and over again, but by actual experience we have found that if the films are thoroughly drained of hypo before being immersed in the wash water, there is not sufficient contamination of this large volume of water circulating through the tank to produce chemical stains on the films. If there are an unusually large number of films to be processed, it is a simple matter to drain the tank at noon, refill with fresh water, and add another 25 pounds of ice. The ice costs less than a couple of 8×10 films and the wash water remains cool during the day.

Prior to the installation of this simple motor driven pump, we cooled the wash water with ice and sloshed the films around until they were supposed to be washed. At the same time, with several films hanging in the tank, we frequently scratched and ruined beautiful films which we were particularly anxious to have come out of the wash water in perfect condition. The whole pump assembly is mounted on a suitable base and rests on a couple of layers of thick felt which absorbs the vibrations and renders the motor pump about as noiseless during operation as an electric fan. A three fourths "Globe" valve was introduced into the discharge line of the pump as a means of controlling the water circulation. If desired, an extra five-gallon tank of water may be placed beside the hypo tank for preliminary rinsing of films before their immersion in the wash tank. However, we have not found this extra wash tank necessary, and whenever the laboratory work increases to a point at which this present method is not practical we will feel justified in obtaining bids on the installation of one of the more elaborate electrical refrigerating plants.

The accompanying illustration shows the motor pump assembly with a standard three fourths inch connection for the supply and discharge lines to the water compartment of the developing tank.

AN UNDIAGNOSED LUNG TUMOR RESPONSE TO IRRADIATION

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From the Radiation Therapy Service, Bellevue
Hospital, Ira I. Kaplan, M.D., Director

That radiation therapy is of little value in the treatment of malignancy of the lung is admitted by most therapists and clinicians. Moderate palliation with but slight alleviation of pain is the most to be expected in the way of relief, and even such results are very infrequent. X-ray therapy has proven of immense aid, however, in treating intrathoracic involvements of the lymphoblastomas, *ie*, Hodgkin's, lymphosarcomas, and in leukemias, and in these conditions relief of pressure symptoms is often immediate and even startling.

Accepting as a dictum the extreme resistance of lung malignancies to irradiation, clinicians have eschewed the use of this therapeutic procedure. While this attitude is probably correct in cases in which a definite diagnosis is established by tissue biopsy through the bronchoscope, a clinical diagnosis, even if substantiated by roentgenogram, should never cause the clinician to reject the use of roentgen-ray therapy, because, by so doing, an occasional error in diagnosis may deprive the patient of the beneficial, relieving effects of this form of therapy. An intrathoracic tumor of the Hodgkin's type or a lymphosarcoma or a leukemia or some obscure condition, may present all the symptoms, all the signs, and even the x-ray findings of a malignancy, but often only its response to irradiation can establish its true nature.

Case History. J. W., age 42, white, a meter worker, American, was admitted to the radiation therapy clinic in June, 1932, complaining of pain in the left shoulder region. The condition had commenced two years previously with the simultaneous occurrence of a dry hacking cough and a dull ache in the lower dorsal area, which radiated to the left scapular region and up to the left shoulder. These symptoms persisted for two years without any aggravation. He neither coughed blood nor had night sweats. During the four months prior to admission, he had lost 15 pounds.

The patient did not appear chronically ill, on the contrary, he was very well developed and well nourished. There were no positive clinical findings aside from dullness and numerous coarse bronchial râles in the left upper chest, heard posteriorly. The Wassermann was negative, and the blood count entirely normal. A radiograph taken at the time of admission (Fig. 1) disclosed a homo-

sible to utilize the "cold" water at a temperature of 82 to 85 degrees for the washing of films. Obviously the temperatures of the

morning 25 pounds of ice are added to the water compartment in preparation for the day's work in the dark room. This amount of

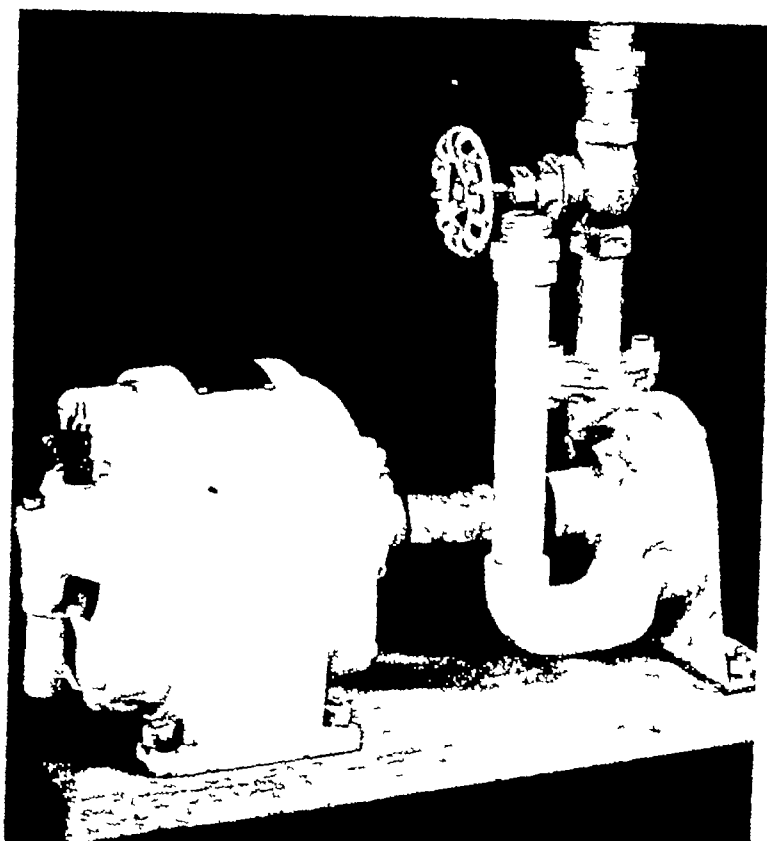


Fig 1 Simple motor driven centrifugal pump assembly with standard three fourths inch connections for the wash tank.

solutions in the smaller compartments are continuously influenced by the temperature of the wash water.

As previously stated, after experimenting with block ice and a copper coil and later with an electrically operated cooling unit which was not properly installed, the method described below was put into operation with a great deal of satisfaction. This method is far from being ideal but the cost is so small and the results so satisfactory that with our present volume of work, we will probably continue to use this method of film washing until we find something more efficient.

At the end of each day's work the water in the "Impermo" tank is drained off into the waste and the tank is filled with fresh water. During the night this water cools to about 80 degrees, about eight o'clock the following

ice cools the 27 gallons of water in the wash tank to approximately 65 degrees F, and the temperature of the solutions will come down to 68 or 70 degrees, depending on the room temperature. A small motor driven centrifugal pump, with suitable connections to the water compartment of the Impermo tank, circulates this cooled water and washes the films in the same manner as when the tap water is run into the bottom of the tank and out through the overflow pipe. The pump takes the water from a three-quarter inch copper pipe, which extends over the edge of the tank and into the water, to within an inch and a half of the bottom of the tank. The water returns to the tank through a similar copper pipe which extends down about two inches below the water level. The pump is connected to these two copper pipes with suit-



Fig 4 Film taken one and one-half years after admission. The mass is the same as when first seen. There is marked retraction of the trachea. Also there is infiltration and fibrosis.



Fig 5 There may be seen a decrease in density of the tumor mass. Tracheal retraction is persistent (sides reversed).

The initial reaction having been so satisfactory, another series of high voltage x-ray was administered in September, 1932, employing the same factors and attacking the same areas. The radiograph (Fig 3) at the end of this series was again interpreted as fibroid and cavernous phthisis. It disclosed additional resolution of the tumor mass as compared to Figure 2.

In January, 1933, there was a recurrence of the pain in the left chest and shoulder, and the area was again irradiated as previously. Three months later, April, 1933, the pain was entirely gone, and the general condition of the patient excellent.

During the next eight months, the patient absented himself from the clinic, being free from all symptoms, but reappeared in January, 1934, when the dull shoulder ache returned. A radiograph (Fig 4) disclosed infiltration, fibrosis, cavitation, and atelectasis, with slight elevation of the diaphragm and considerable retraction of the superior mediastinum and trachea. These findings were again interpreted by the x-ray service as a neoplastic infiltration, and the physicians there were again willing to make that diagnosis. The lesion showed a distinct aggravation compared to Figure 3, and appeared almost similar to the first film. Treatment was again instituted as before, giving 1,200 r to the anterior and posterior chest. The last film (Fig 5), taken in March, 1934, disclosed a pronounced resolution of the tumor mass. The shoulder pain was entirely relieved and the status of the patient was again that of "feeling youthful."

Summary and Conclusions—This case is of unusual interest because x-ray therapy was the deciding factor in eliminating carcinoma as a diagnosis. To date, after careful observa-

tion and more detailed clinical work-up, no definite entity has been established, but the patient receives considerable symptomatic relief from the treatments. Furthermore, changes indicative of improvement are evidenced on the films. He has learned to come to the clinic as soon as pains recur, or when his general condition falls below normal comfort. Without x-ray therapy these highly gratifying results would not have been obtained.

We hope this case presentation will serve to further the trial of irradiation when a clinical diagnosis of lung carcinoma, without tissue biopsy, is made.

55 East 86th Street

THE ROENTGENOLOGICAL POSITION OF THE POTENTIAL INTERLOBAR SPACES

AN EXPERIMENTAL STUDY¹

By JOSEPH LEVITIN, M D, *San Francisco*

From the Department of Roentgenology Mt Zion Hospital

The interlobar fissures (potential interlobar spaces) are frequently the site of disease processes. These are usually in the nature of effusions, which may be transudates or exudates. Since clinical signs of interlobar effusions are lacking or difficult to interpret, the x-ray examination may be of great aid in establishing a differential diagnosis between intrapulmonary involvements and effusions into the interlobar spaces. An exact knowledge of the anatomical relationships of the

¹ Supported by a gift from the A. Brown Chest Fund.



Fig 1 Film taken on admission. Tumor mass may be seen in upper left lung field. There is some widening of the mediastinum to the right and a slight elevation of the left dome of the diaphragm.

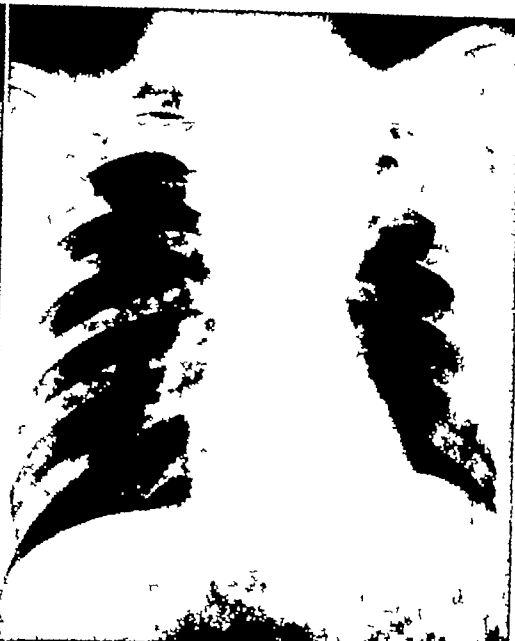


Fig 2 Film taken two months after treatment. There may be seen a slight resolution of the mass. Fibrosis predominates.

geneous decrease in illumination of the upper half of the left lung-field, slight elevation of the left dome of the diaphragm, some widen-

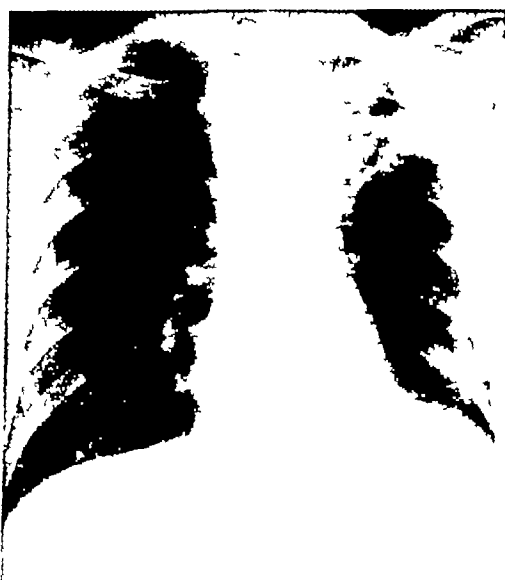


Fig 3 Film taken four months after admission. There is further resolution interpreted as fibroid and cavernous pthithis. The patient has greatly improved.

ing of the mediastinum to the right—altogether very suggestive of a neoplastic infiltration. On bronchoscopy, the left upper bronchus was found plugged with thick tenacious exudate, which, on removal, revealed a normal mucosal lining and no tumor growth.

In the absence of tissue biopsy, we established a clinical diagnosis of lung carcinoma, and therapy was instituted with 200 KV, 4 ma, using an open cone at 40 cm distance directed to the left lung anteriorly and posteriorly. The dosage was 1,600 r to each area.

Two months after the completion of this first series of treatments, the patient was remarkably improved. He had gained eight pounds, the appetite had become ravenous, and his general well-being made him 'feel youthful.' Another radiograph (Fig 2), taken at this time, was interpreted by the x-ray service as fibroid tuberculosis.

With this diagnosis we were inclined to concur because the nature of the response had removed the condition from all likelihood of a malignancy. The tuberculosis service was consulted, but Dr Amberson and staff were not ready to make a positive diagnosis of consumption. They requested and examined a three-day sputum specimen which, however, did not disclose any tubercle bacilli.

Fig 1 Right lung The x-ray appearance of the potential interlobar space between the upper and lower lobes. The septum between these lobes extends obliquely upward and backward from the hilum. In the anteroposterior view, the lower border is a straight line extending horizontally outward from the hilum to the lateral chest wall. The upper border is convex, corresponding to the contour of the upper limits of the lower lobe. A study of the lateral view demonstrates the oblique course of the septum and explains why the upper border which actually starts at the level of the fourth rib posteriorly, would, by vertical projection of the x-ray, overlap the second rib anteriorly. The upper and lower lobes approximate each other only posteriorly. (See p 630)

Fig 2 Right lung The x-ray appearance of the potential interlobar space between the upper and middle lobes. In the anteroposterior view, the upper border is a straight line extending outward from the hilum to the lateral chest wall. The lower border is convex following the boundary of the anterior fissure between the upper and middle lobes. The lateral view shows the septum to lie horizontally, extending forward from the hilum to the anterior chest wall. (See p 630)

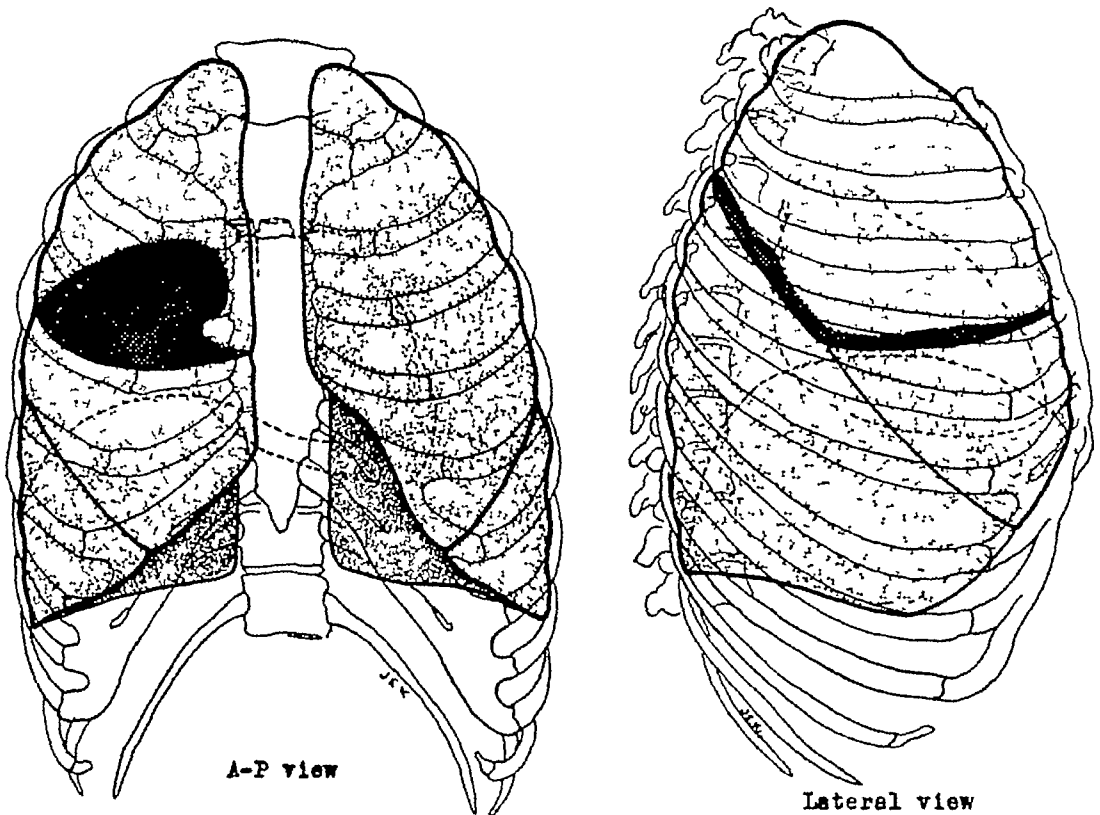


Fig 3 Right lung X-ray appearance of the potential interlobar space bounding the entire right upper lobe. This is a combination of the shadows in Figures 1 and 2. The shadow is made up of the septum between the upper and middle lobes anteriorly, and the upper and lower lobes posteriorly. The shadow in the anteroposterior view is broader and easily mistaken for a parenchymatous involvement. The lateral view aids in establishing the location of this shadow.

potential interlobar spaces as they appear radiologically must be available before abnormal x-ray findings involving these fissures can be interpreted. The study herewith reported was undertaken to establish the roentgenologic position of the interlobar fissures.

The course of the major fissures on both sides is from the level of the spinous process of the third dorsal vertebra posteriorly, obliquely downward and forward to the costochondral articulation of the sixth rib anteriorly. On the right side another fissure extends horizontally

forward from the axilla to the costochondral articulation of the fourth rib. The fissures divide the right lung into three lobes and the left lung into two. On account of their oblique course disease processes involving these fissures which are of sufficient density to cast a shadow will be seen as broad shadows in the postero-anterior view. The exception is that fissure between the upper and middle lobes which lies in the same horizontal plane as the projected x-ray. This shadow will be seen as a narrow band or thin line. In the lateral view the

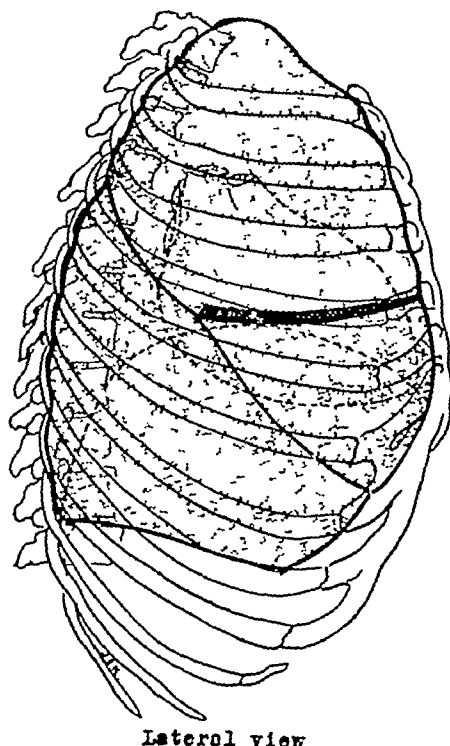
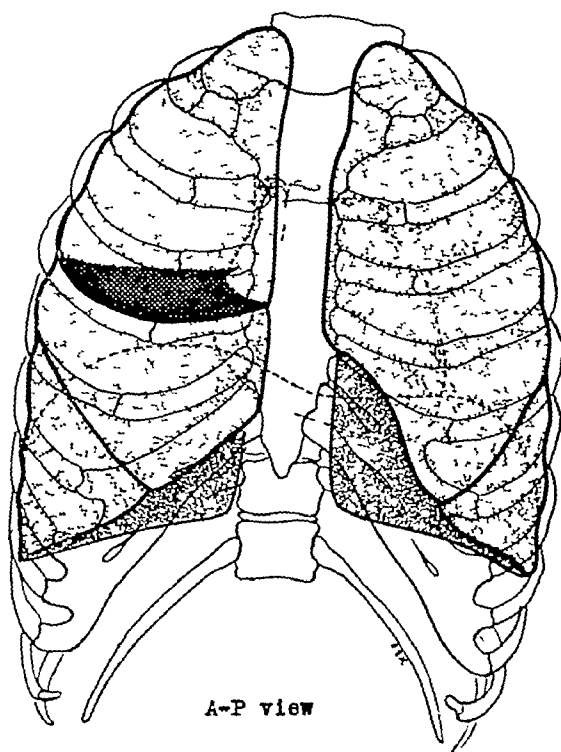
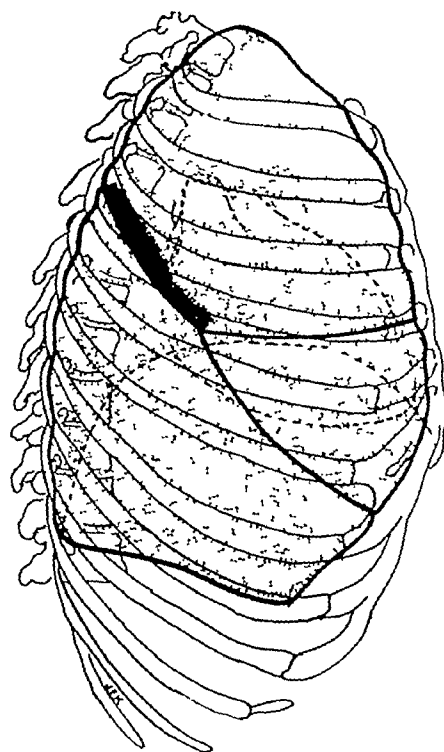
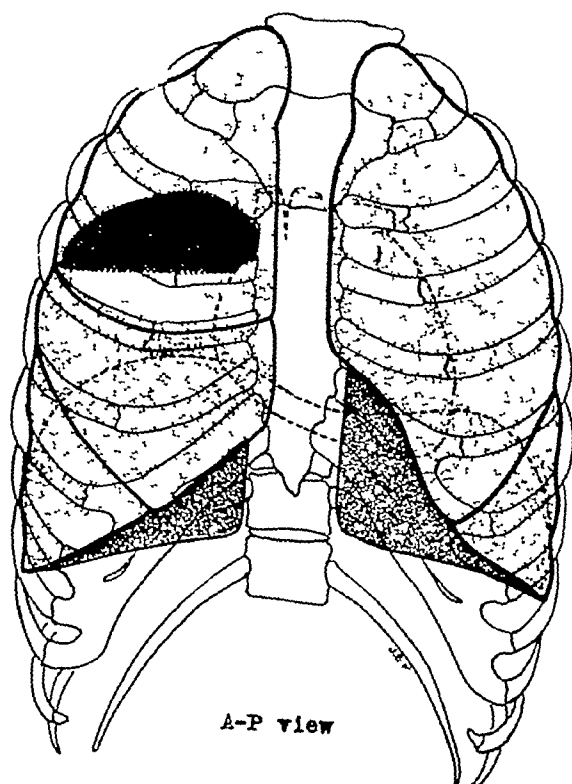


Fig 1 (above) and Fig 2 (below)

Fig 4 Right lung X-ray appearance of the potential interlobar space between the middle and lower lobes. The appearance of this septum in the anteroposterior view is that of a broad shadow occupying the lower half of the chest, with a horizontal upper border. A small clear area of lung, which is seen in the axilla at the base, represents the lower lobe which in this position extends anteriorly. The differentiation of the shadow, which occupies the entire area of the middle lobe from a consolidation or atelectasis of the middle lobe can be made from the lateral view. Here we find an almost linear shadow extending obliquely downward and forward from the hilum. This interlobar space is the one most frequently involved by interlobar effusions. (See p 632)

Fig 5 The x-ray appearance of the potential interlobar space bounding the entire upper border of the right lower lobe. This is a combined shadow of Figures 1 and 4. As result of the oblique course of this septum and the broad surface of the lower lobe, the shadow obtained in the anteroposterior view is that of a broad bean-shaped area which might be confused with a lung tumor or a large area of lung consolidation. The lateral view is of aid in establishing the oblique course of this shadow, locating it in the region of the interlobar septum.

A combination of pathologic changes involving all three septa would give a shadow as seen in Figure 5, in the anteroposterior view. The shadow of an additional interlobar effusion between the upper and middle lobes would superimpose itself on the shadow already obtained. The lateral view would clearly demonstrate the position of these shadows between the lobes. (See p 632)

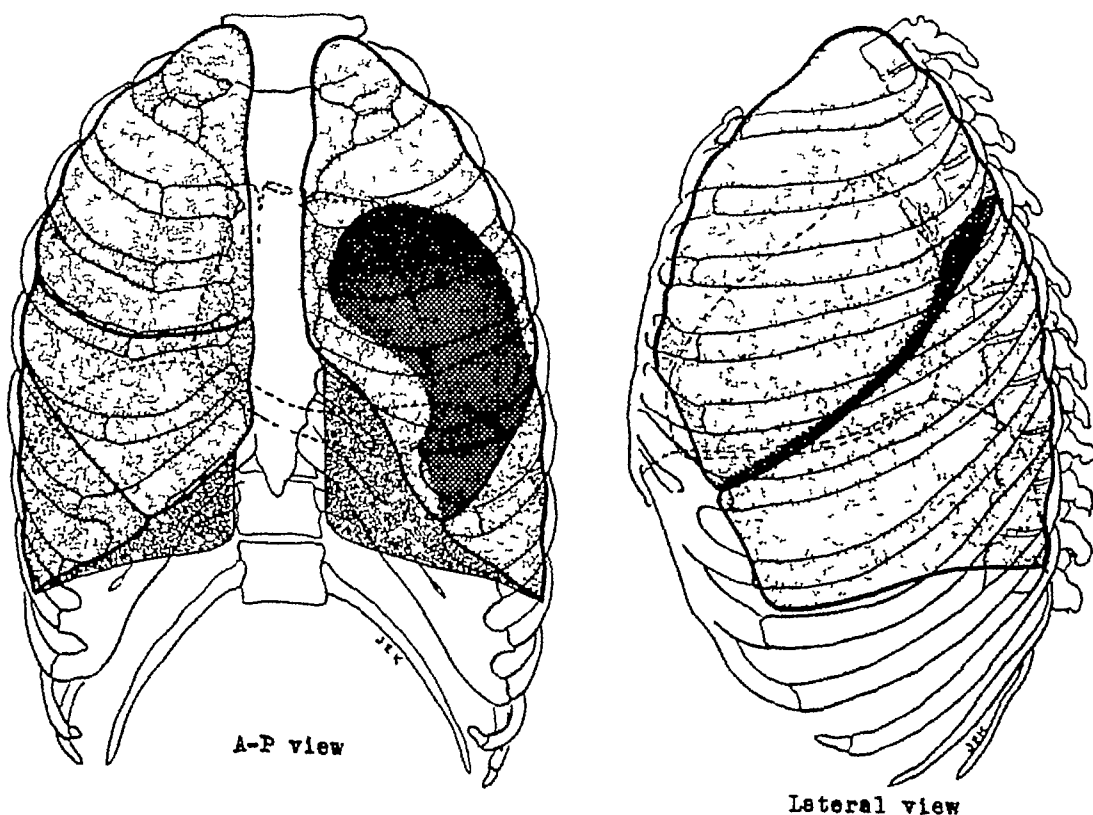


Fig 6 Left lung X ray appearance of the potential interlobar space between upper and lower lobes. With only two lobes on the left side, the possible combinations of superimposed shadows are reduced. The shadow of the entire septum is similar to that of Figure 5. Parts of the septum—as that extending posteriorly—would resemble that of Figure 1. The septum extending from the hilum forward would be similar to the shadow in Figure 4. Abnormal interlobar changes on the left side are not as frequent as on the right.

fissures also appear as narrow bands or lines. In this instance the course of the fissure is in the same plane as the projected x-ray.

Chaoul and Stierlin² suggest taking chest

² Year Book of Radiology, 1932, Charles A. Waters and Ira I. Kaplan, p. 241. Abstract from E. Liebmann, *Lehrbuch der Röntgendiagnostik*, II, Georg Thieme, Leipzig, 1932.

films to define interlobar space disease with the ray directed in several planes. The interlobar effusion will show a broad shadow when the direction of the ray is at right-angles to the plane of the process. The shadow will become narrower as the direction of the ray approaches the plane of the fissure.

Very often we are called upon to make interpretations of x-ray films taken at the bedside.

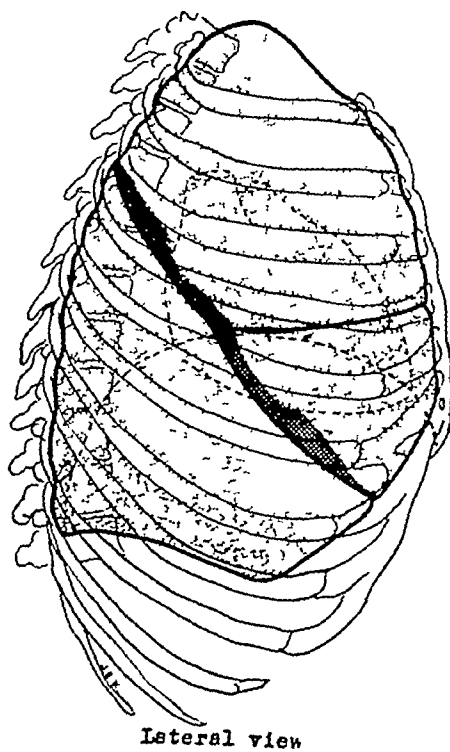
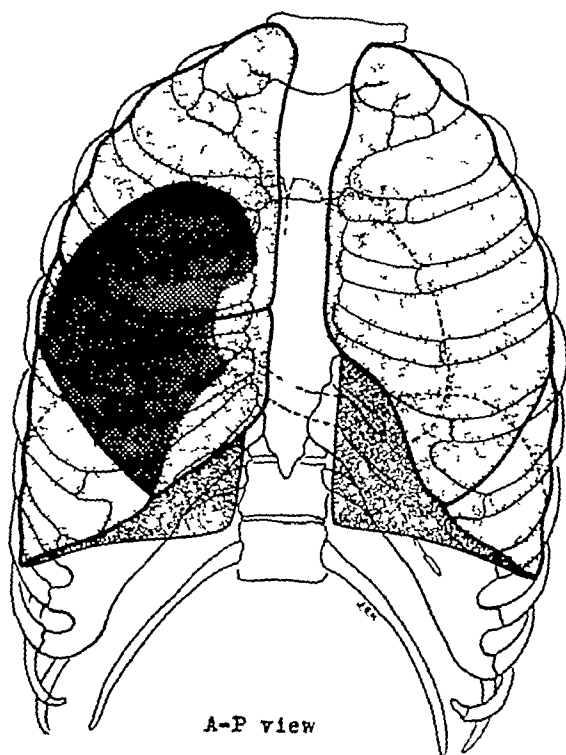
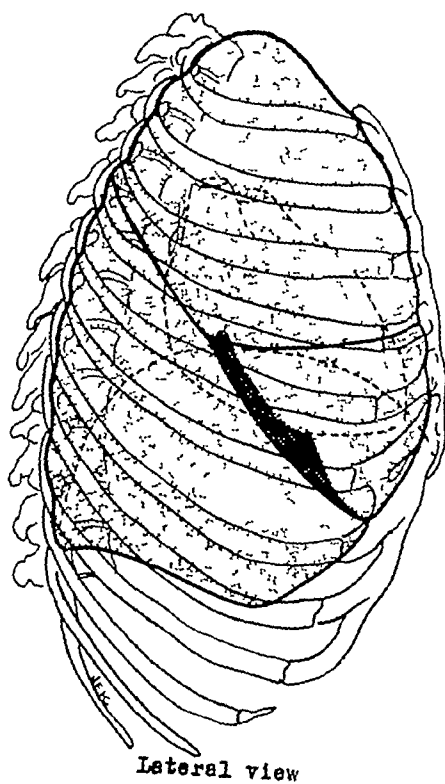
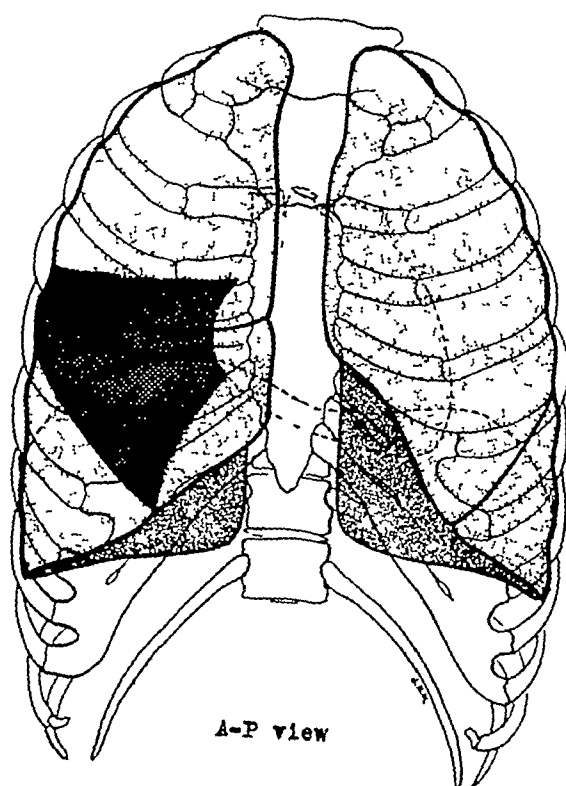


Fig 4 (above) and Fig 5 (below)

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE X-RAY PROBLEM AND A SOLUTION

A DISCUSSION OF THE PROPOSED SEPARATION OF THE X-RAY EXAMINATION INTO TECHNICAL AND PROFESSIONAL PORTIONS¹

Genesis—The immediate cause for the consideration of this problem is the desire or necessity of hospitals to include x-ray and laboratory work with hospitalization in hospital insurance plans. The inclusion of the professional services of the radiologist in such plans of insurance places the hospital in the position of attempting to practise medicine. Desiring to circumvent such illegal practice it occurred, therefore, to some hospital superintendents to separate the x-ray charge into two parts, a so called technical charge and a professional charge. They propose to give the first along with and as a part of hospitalization and let the roentgenologist charge the second *only* when called in consultation. The real genesis, therefore, lies in the peculiar relationship between hospitals and roentgenologists.

Problem of Dual Interest—It is perfectly obvious that there are two interests involved in the practice of roentgenology in a hospital. The hospital has an investment in equipment, an interest in rent for floor space, and usually provides technical and stenographic services and supplies to the department. It thus has a definite interest in the money to be collected. On the other hand, the physician practising roentgenology practises his specialty with the use of the equipment and personnel and also has an interest in the money collected.

Division of Dual Interest—It would seem logical on superficial examination of the subject to divide the fee for x-ray service into two parts, one to cover overhead and one to cover professional service. The difficult problem is where to divide the fees. Some hospitals claim that it is a hospital procedure up to the point of interpretation, that they can produce roentgenograms without any but lay help,

others, having tried this plan realize that the production of adequate roentgenograms requires the services of a roentgenologist and is truly a professional or professional-technical procedure (just as operative surgery is a professional-technical procedure). The following arguments are submitted to show that the hospital actually has no interest beyond the providing of the proper space, equipment, materials, and personnel and *actually should not be allowed to attempt the production of roentgenograms without the services of the roentgenologist*. Fluoroscopic examinations and roentgen diagnoses are assumed without argument to be medical procedures.

Hospitals should not Produce Roentgenograms—*Firstly*, because the technical work of producing a roentgenogram is a medical procedure.

(a) It involves the penetration of the human body by a very dangerous physical agent. In this sense, it is as much a medical procedure as the administering of drugs intravenously, subcutaneously, or by any way other than the patient's own conscious act.

(b) A knowledge of medical anatomy and at least a working knowledge of gross pathology is necessary to properly direct the angles of projection in order to demonstrate the various parts involved, and in some cases a knowledge of diseases is required really to know what is to be shown.

(c) Medical judgment is required to decide the adequacy or inadequacy of the films obtained.

(d) The making of films is part of the examination of ill, often seriously ill, persons and thus should be under the immediate direction of a physician (roentgenologist).

The statement that the technical side of roentgenography is not a medical procedure originates most frequently from those who are not in close contact with x-ray or hospital de-

¹ Presented by the Executive Committee of the Pacific Roentgen Club: Lowell S. Gorn, M.D., *Chairman*; I. Henry Garland, M.D., *Secretary*; John D. Lawson, M.D.; Henry Snure, M.D.; and Robert S. Stone, M.D.

The condition of the patient may have been such that a complete examination could not be made. A knowledge of the appearance of the fissures in the postero-anterior view would be of great aid in the interpretation of the densities seen on the film. This present study was made for the purpose of providing standard charts of the x-ray position of the interlobar fissures.

Models of the lobes were made of paraffin, which is transparent to the x-ray. The models were fitted into a thoracic skeleton. Lead foil about one-fourth of a millimeter in thickness was placed between the various lobes of the paraffin models and films were taken in postero-anterior and lateral projections. Because of artefacts in the preparation of the skeleton, the roentgenograms obtained were subsequently diagrammed. In the prepared diagrams the position of the heart was indicated by dotted lines. The fissures of the

surface of the lung as seen on the frontal and sagittal surfaces were indicated by a heavy black line. The interlobar fissure studied was indicated by a heavy checkered shadow. A high diaphragm adds to the difficulty of interpretation. At full expiration the diaphragm rises to a height on the plane with the level of the lower border of the fourth rib. This masks a considerable portion of the lung. The diaphragm was indicated on the diagrams at full expiration.

The following diagrams illustrate the location and appearance of the interlobar fissures between the various lobes as they appear on the x-ray film.

The clinical value of these anatomical facts and an interpretive study of pathological intrathoracic x-ray findings is to be presented in a subsequent article. Naturally, partial effusions present only fragmentary pictures of the sort seen in the diagram.

guise of calling it a technical procedure. The actual operation in surgery is in the same sense a technical procedure, auscultation and percussion are technical procedures, cystoscopic examinations are technical procedures. If all of these are separated from physicians, how will medicine, including radiology, advance or even maintain its present position? X-ray technicians must be trained by physicians. Who will train them when the specialty of radiology no longer exists? This whole proposal of technical division is a retrograde step.

The hospital has a just and proper interest in its equipment, in its space, and in its personnel, but here the interest ceases. It can charge for the materials, interest on investment, salaries, and rental but not for the production of roentgenograms. If the hospital is able to hold out as part of the bait for its insurance policy only the strictly hospital portion of the x-ray examination and if the patient has to pay the recognized roentgenologist for the rest, the bait will not be big enough. There seem to be better ways of protecting the hospital's interest than the division of the medical x-ray examination into two artificial portions. One of these is the maintenance of the quality and soundness of the medical care practised in the hospital, the other is the recognition of the rights of the medical profession, that in the final analysis actually make the hospital what it is—a living institution for the care of the sick *in the hospital*.

ANNOUNCEMENTS

ANNUAL MEETING

ENTERTAINMENT

Among the entertainments planned by our Memphis hosts are the following:

Tuesday Luncheon for the ladies attending, at the Memphis Country Club.

Wednesday, 10 A M Mrs. McGuffin's breakfast for the Counselors' wives—Georgian Room, Hotel Peabody.

Wednesday afternoon Musicales and tea given by the ladies of the Memphis Doctors Auxiliary at the home of Dr. and Mrs. Willis Campbell, Morningside Drive.

Thursday afternoon Sightseeing automobile ride to points of interest. Refreshments served at the home of Dr. and Mrs. W. S. Lawrence, 1622 Central Ave., after the drive.

Thursday evening Banquet.

The Stag Party will be given at Hotel Gayoso, 8 P M., Wednesday.

All of the golf clubs in and around Memphis, also hunting and fishing clubs, will be open to the visiting doctors.

Local Transportation—Due to the proximity of other hotels to the Peabody (headquarters hotel) the local transportation problem is not a serious one. There will always be, however, an ample supply of automobiles and taxicabs in case of inclement weather. For those who come to Memphis by motor, there will be adequate parking garages in connection with all of the hotels.

Rotary Club Luncheon, at which Dr. Wood's address will be given, will be held in the main dining room of Hotel Gayoso at 12:30 P M., Tuesday, within easy walking distance of Hotel Peabody.

The Carman Lecture will be given in the ballroom of the Peabody Hotel, Tuesday evening.

ANNUAL MEETING

MEMPHIS HOTELS

Location, and additional notice regarding rates

The Memphis hotels are well grouped in the downtown district. All of them are entirely modern, have been kept in excellent shape throughout the depression, and are accustomed to the handling of convention guests. Memphis entertains more than 300 conventions every year.

The headquarters hotel is Hotel Peabody, the rates of which are from \$3.00 to \$5.00 single, \$4.00 to \$6.00 double, and \$6.00 to \$8.00 for rooms with twin beds.

Across the street from the Hotel Peabody is Hotel Tennessee, which provides first class rooms with baths at \$2.00 to \$3.00 single, and \$3.00 to \$4.50 double.

Two blocks away is Hotel William Len, the rates of which are \$2.00 to \$3.00 single, \$3.00 to \$4.00 double, and \$4.50 to \$5.00 for rooms with baths.

At the same distance from Hotel Peabody is Hotel Gayoso, the rates of which are \$2.00 to \$4.00 single, and \$3.50 to \$6.00 double.

Hotel Claridge is located about six blocks from Hotel Peabody. Its rates are \$2.50 to \$3.00 single, \$3.50 to \$5.00 double, and \$4.00 to \$5.00 for twin beds.

The rates at Hotel DeVoy, which is about the same distance from Hotel Peabody as is Hotel

partments wherein they would see readily how often the roentgenologist is consulted by the technical staff on various cases. When a roentgenologist makes the statement, he always assumes medical supervision. Any act which requires medical supervision is *per se* a professional act.

Secondly, because it is not possible to entrust the entire examination to a lay technician even though we grant that some lay technicians can do a great deal of the work adequately. Credit should be given to roentgenologists that they have been able to train so well relatively inexpensive assistants and thereby lower the cost of radiographic work.

(a) Just as many surgeons' nurses take care of much of the routine surgical dressings and in many of the hospitals assist at operations, but are not allowed to do these same things except under supervision, so x-ray technicians may do many technical procedures but they should be under the supervision and direct control of a medical person.

(b) Any case deviating from the routine requires a medical opinion from a roentgenologist as to whether more studies are needed to elucidate the problem. The value of most roentgenologic departments varies with the amount of time and supervision given by the roentgenologist. Hospitals have realized this in asking for "full-time" roentgenologists.

(c) Same as (c), above, in "Firstly."

(d) Same as (b), above, in "Firstly."

(e) Such a procedure artificially separates the method of examination from the interpretation of results. This sometimes causes serious misunderstandings and mistakes.

(f) Lay-controlled departments have proved unsatisfactory.

Thirdly, because the analogy between surgery and x-ray which has been advanced very often shows the true situation. In surgery, the hospital provides operating rooms, instruments, and nurses but does not attempt to use these instruments. In some medical departments, the hospital provides blood pressure apparatus, stethoscopes, and ophthalmoscopes, but does not attempt to use them. In the x-ray department, by comparison, the hospital may provide x-ray apparatus, rooms, technicians, and clerical assistants but should not use them without medical supervision and, therefore, should not attempt to produce roentgenograms.

Problem of Specialization—Granting all the above, it could be argued that the attending

physician should be able to direct the x-ray examination. The fact remains, however, that, with few exceptions, he is not able to do so. If he were so able, roentgenology as a specialty would not have developed. The average conscientious physician or surgeon will admit his inability to direct the entire x-ray examinations. X-ray technic in theory and in practice is so specialized that it is not possible to train all physicians in it. Good hospitals do not allow any but qualified surgeons to operate in the surgery. No more should they allow any but qualified roentgenologists to operate in the department of roentgenology.

It might be argued that many of the simpler procedures could be done by a lay technical staff directed by the general practitioner. The fallacy of this is well shown by the average run of films from hospitals in small towns where this is done by necessity.

It is self-evident that if men of any talent are to be attracted to the field of roentgenology so that it can continue to advance, both for the improvement of diagnostic medical practice and for the general good of humanity, there must be sufficient rewards to make it attractive. The surgeon is able to do many minor things without charge because he can collect such large fees for his technical (operative) work. The roentgenologist is not able to collect any such large fees and, therefore, must make small amounts from each examination. If the minor examinations were to be removed from his category, to eke out even a living he would have to charge more for the major examinations.

One practical difficulty in dividing the fee for x-ray service is that with charges of such small denomination, the patients would object to paying two fees. Presuming they paid the hospital fees first, they would assume that they had paid for their roentgenological examination and would not pay an interpretive or diagnostic charge when this was submitted by the doctor. Neither the lay public nor the medical profession has been educated to the two-fee idea.

Conclusions—The x-ray examination is, and always has been, fundamentally a medical procedure. Roentgenology as a science is still in its infancy. The medical profession as a whole should not stand by idly while short-sighted lay interests and hospitals try to take over this phase of medical practice under the

- 10 I S Trostler, M D , Chicago
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Differential Diagnosis of Pulmonary Conditions
- 11 John Russell Carty, M D , New York Hospital, New York City
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- 12 W E Caldwell, M D , H C Moloy, M D , and P C Swenson, M D , Sloane Maternity Hospital for Women, and Roentgen Department, Presbyterian Hospital, New York City
Anatomical Variations in the Female Pelvis Their Obstetrical Significance
- 13 H. B Podlasky, M D , Milwaukee, Wisconsin
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Lungs of Anthracite Miners of Pennsylvania All Subjects Working and Apparently in Perfect Health
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Century of Progress Exhibit
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Tumors of the Breast
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Bone Tumors
- 29 John D Camp, M D , Mayo Clinic, Rochester, Minn
The Roentgen Localization of Spinal Cord Tumors

COMMERCIAL EXHIBITORS

The following Commercial Exhibitors have requested space to show their products at the Annual Meeting

- 1 Buck X-ray Company, of St Louis
- 2 Du Pont Film Manufacturing Company, of New York City
- 3 Eastman Kodak Company, of Rochester, New York
- 4 E Fougera & Company, of New York City
- 5 General Electric X-ray Corporation, of Chicago
- 6 Kelley-Koett Manufacturing Company, Inc , of Covington, Ky
- 7 Mallinckrodt Chemical Works, of St Louis
- 8 Medical Bureau, of Chicago
- 9 Patterson Screen Company, of Towanda, Pennsylvania
- 10 Philips-Metall Corporation, of New York City
- 11 Picker X-ray Corporation, of New York City
- 12 Radon Company, Inc , of New York City

Clandage, are \$1 75 to \$4 00 single, and \$2 50 to \$6 00 double

Hotel Chisca is about five blocks from Hotel Peabody, and its rates are \$2 00 to \$5 00 single, \$3 00 to \$6 50 double, and \$4 00 to \$5 00 with twin beds

Next door to the Hotel Chisca is Hotel Adler, the rates of which are approximately the same as those of Hotel Tennessee

Hotel Ambassador is six blocks from Hotel Peabody, and its rates are \$1 00 to \$1 50 single, \$2 00 to \$2 50 double, and \$4 00 for rooms with twin beds

Hotel Parkview is located opposite Overton Park in the residential district, about two miles from Hotel Peabody Its rates are \$2 50 to \$3 00 single, and \$3 00 to \$4 00 double

The number of reservations to date indicates a large attendance I suggest that you write for your reservation without further delay in order that you may secure the accommodations desired

J CASH KING, M D ,
Hotel Committee, *Chairman*

915 Madison, Memphis, Tennessee

TRANSPORTATION FOR THE MEMPHIS MEETING

DEC 3 TO 7, INCLUSIVE

The Transportation Committee has secured the adoption of the straight certificate plan of reduced fares At the time the ticket is purchased, each member secures a certificate for himself and each dependent member of his family attending the meeting He secures this certificate from the agent selling him the ticket and pays the full one-way fare This certificate is validated at the meeting and, provided 100 certificates are presented for validation, a return ticket may be purchased for one-third the regular fare No diversification of route is permitted under this plan All the passenger associations in the United States have agreed to this plan and the Canadian association for the eastern part of Canada The Committee and the officers of the Society are very anxious for all attending the meeting to avail themselves of this reduced fare

In the territory of the Southeastern Passenger Association, which is south of the Ohio and east of the Mississippi rivers, there are daily return reduced fares that permit of diversified routes In some instances these

rates are less than the regular fare plus one-third

Be sure to get your certificate at the time you purchase your ticket

SCIENTIFIC EXHIBITORS

At the Annual Meeting, to be held at the Peabody Hotel, Memphis, the following Scientific Exhibits have been arranged, according to W W Robinson, M D, Chairman of the local committee on Scientific Exhibits Others may be added before the final date

- 1 Ira I Kaplan, M D, Milton Friedman, M D, and Rieva Rosh, M D, Radiation Therapy Department, Bellevue Hospital, New York City
Protracted External Irradiation Comparison of Different Techniques
- 2 C J Buchner, M D, and Theodore Fetter, M D, Jefferson Medical College and Hospital, Philadelphia
Renal Tuberculosis
- 3 H N Pulliam, M D, and L W Diggs, M D, University of Tennessee, Memphis, Tenn
Sickle-cell Anemia
- 4 John R Evans, M D, Denver, Colo
The Obstetric Pelvis
- 5 Samuel Brown, M D, and J E McCarthy, M D, University of Cincinnati, Cincinnati
The Position of the Esophagus under Abnormal Conditions of the Heart and Great Blood Vessels
- 6 A N Arneson, M D, and Edith H Qumby, M A, Memorial Hospital, New York City
Roentgen Radiation in Carcinoma of Cervix Uteri Distribution of Radiation within the Female Pelvis for Different Port Arrangements and Target skin Distances
- 7 Gentz Perry, M D, Evanston, Ill
New Safety Control Devices for Filters in X-ray Therapy
- 8 Raphael Pomeranz, M D, Newark, N J
Acute Silicosis Cases in Pulverizing Plants in New Jersey A Radiologic, Microscopic, and Experimental Survey
- 9 I Seth Hirsch, M D, New York University Medical School, New York City
Roentgen Kymography The Graphic Representation of Visceral Movements

- 10 I S Trostler, M D , Chicago
Differential Diagnosis of Gastric Conditions
Differential Diagnosis of Pulmonary Conditions
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-

EXAMINATIONS BY AMERICAN BOARD OF RADIOLOGY

All radiologists wishing to take the examination of the American Board of Radiology should present themselves for that purpose at the Annual Meeting of the Radiological Society of North America, in Memphis. The exact dates and details may be learned by application to the Secretary of the Board, B R Kirklin, M D, Mayo Clinic, Rochester, Minn., and no time should be lost in getting in touch with him.

COMMUNICATION

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in connection with the meeting of the Minnesota State Medical Association in Duluth, Minnesota, July 16, 1934. The following program was presented

Cholecystographic Findings in a Series of Cases Operated Upon Edward Schons, M D, St. Paul

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BOOK REVIEWS

DILATATIONS OF THE BRONCHI CLINIC, PATHOGENESIS, DIAGNOSIS, AND TREATMENT (*Les Dilatations des Bronches Clinique, Pathogénie, Diagnostique et Traitement*) By MICHEL LÉON-KINDBERG, Médecin des Hôpitaux de Paris. A paper-bound volume of 126 pages, with 20 illustrations. Masson et Cie, Paris, 1934. Price, 22 francs.

This interesting monograph was written by an internist who is regarded as one of the highest authorities in France on bronchiectasis, and who has seen much of the work of André Soulas.

In the introduction is a brief summary of the evolution of the knowledge about bronchiectasis from Laennec's classical description to the more current views. The author believes that little has been added to Laennec's original description, and that a study of the development or evolution of bronchiectasis would be of value.

From his large clinical experience he believes that bronchial dilatations result not from one chronic infection of the entire respiratory tract necessarily, but develop from intercurrent infections and complications which flare up and are oftentimes local. They may also be caused by pulmonary tuberculosis, foreign bodies, certain bronchopneumonias, unresolved pneumonias, and above all by abscesses and gangrenous infections. Congenital conditions may play a part. No individual specific organism appeared to be responsible. Several interesting reproductions of microscopic sections are presented showing various phases of bronchiectasis.

Bronchiectasis in infants is more frequent than generally realized and varies from mild to severe cases. There is the acute form observed at or during the course of the primary infection as whooping cough, bronchopneumonia, and respiratory infections following the acute exanthemas. These acute conditions may subside and have only a few focal signs which may characterize the whole condition of chronic ectasis. Following this there is often healing, and then a recurrence which the physician usually thinks of as a new infection unless he understands the true nature of the evolution of bronchiectasis. These so called 'new infections' show the same clinical picture, and are really only a 'flare up' of the old grave infection. The lesions are usually insidious and progressive. Manifestations of

dilatations may be completely absent during the interval before recurrence of the infection, and these cases often are erroneously diagnosed as tuberculosis. Chronic bronchitis *per se* does not seem to be a cause of bronchial dilatations, but any superimposed grave infection, especially if it predisposes to necrosis, may cause a dilatation.

In the adult, bronchiectasis produces a more varied clinical picture than in children. In cases followed for a long time the author believed the primary infection to have occurred a long time previously.

The clinical pictures of bronchiectasis in children and adults are discussed. The symptoms vary from mild to severe and often no classical picture is present to enable a correct diagnosis to be made. The author advocates either roentgenograms or lipiodol injections of the bronchi or bronchoscopy as diagnostic measures. He believes that routine roentgen examinations of the chest are often unsatisfactory, but injection of iodized poppy-seed oil into the bronchi through a nasal catheter followed by a roentgen examination, will show even the very early cases. Several reproductions of roentgenograms illustrating these observations are shown. The second method is the bronchoscopic examination. A figure is shown which demonstrates the various steps in passing the scope. Bronchoscopy is also of use in giving valuable information concerning the condition of the mucosa, anatomical structure, anomalies and abnormalities, and of the presence or absence of neoplasms.

In treatment, the author feels that bronchoscopy is the treatment of choice, especially in early cases. It is palliative and often curative, having another advantage of being practically without risk. Lobectomy, progressive exercises, and collapse therapy have very limited indications.

A bibliography of 181 references, while not complete as the author states, lists many important articles, and may at least be considered as representative of the literature upon this subject.

HAROLD WALTZ, M D

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS JOHN ALBERT KEY, B S, M D, Clinical Professor of Orthopedic Surgery, Washington University School of Medicine, Associate Surgeon, Barnes, Children's, and Jewish Hospitals, St

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In the introduction is a brief summary of the evolution of the knowledge about bronchiectasis from Laennec's classical description to the more current views. The author believes that little has been added to Laennec's original description, and that a study of the development or evolution of bronchiectasis would be of value.

From his large clinical experience he believes that bronchial dilatations result not from one chronic infection of the entire respiratory tract necessarily, but develop from intercurrent infections and complications which flare up and are oftentimes local. They may also be caused by pulmonary tuberculosis, foreign bodies, certain bronchopneumonias, unresolved pneumonias, and above all by abscesses and gangrenous infections. Congenital conditions may play a part. No individual specific organism appeared to be responsible. Several interesting reproductions of microscopic sections are presented showing various phases of bronchiectasis.

Bronchiectasis in infants is more frequent than generally realized and varies from mild to severe cases. There is the acute form observed at or during the course of the primary infection as whooping cough, bronchopneumonia, and respiratory infections following the acute exanthemas. These acute conditions may subside and have only a few focal signs which may characterize the whole condition of chronic ectasis. Following this there is often healing, and then a recurrence which the physician usually thinks of as a new infection unless he understands the true nature of the evolution of bronchiectasis. These so called "new infections" show the same clinical picture, and are really only a "flare up" of the old grave infection. The lesions are usually insidious and progressive. Manifestations of

dilatations may be completely absent during the interval before recurrence of the infection, and these cases often are erroneously diagnosed as tuberculosis. Chronic bronchitis *per se* does not seem to be a cause of bronchial dilatations, but any superimposed grave infection, especially if it predisposes to necrosis, may cause a dilatation.

In the adult, bronchiectasis produces a more varied clinical picture than in children. In cases followed for a long time the author believed the primary infection to have occurred a long time previously.

The clinical pictures of bronchiectasis in children and adults are discussed. The symptoms vary from mild to severe and often no classical picture is present to enable a correct diagnosis to be made. The author advocates either roentgenograms or lipiodol injections of the bronchi or bronchoscopy as diagnostic measures. He believes that routine roentgen examinations of the chest are often unsatisfactory, but injection of iodized poppy-seed oil into the bronchi through a nasal catheter followed by a roentgen examination, will show even the very early cases. Several reproductions of roentgenograms illustrating these observations are shown. The second method is the bronchoscopic examination. A figure is shown which demonstrates the various steps in passing the scope. Bronchoscopy is also of use in giving valuable information concerning the condition of the mucosa, anatomical structure, anomalies and abnormalities, and of the presence or absence of neoplasms.

In treatment, the author feels that bronchoscopy is the treatment of choice, especially in early cases. It is palliative and often curative, having another advantage of being practically without risk. Lobectomy, progressive exercises, and collapse therapy have very limited indications.

A bibliography of 181 references, while not complete as the author states, lists many important articles, and may at least be considered as representative of the literature upon this subject.

HAROLD WALTZ, M D

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. JOHN ALBERT KEY, B S, M D, Clinical Professor of Orthopedic Surgery, Washington University School of Medicine, Associate Surgeon, Barnes, Children's, and Jewish Hospitals, St

- 13 Standard X-ray Company, of Chicago
- 14 Victoreen Instrument Company, of Cleveland, Ohio
- 15 Westinghouse X-ray Company, Inc., of Long Island City, N Y

EXAMINATIONS BY AMERICAN BOARD OF RADIOLOGY

All radiologists wishing to take the examination of the American Board of Radiology should present themselves for that purpose at the Annual Meeting of the Radiological Society of North America, in Memphis. The exact dates and details may be learned by application to the Secretary of the Board, B R Kirklin, M D, Mayo Clinic, Rochester, Minn., and no time should be lost in getting in touch with him.

COMMUNICATION

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in connection with the meeting of the Minnesota State Medical Association in Duluth, Minnesota, July 16, 1934. The following program was presented:

- Cholecystographic Findings in a Series of Cases Operated Upon Edward Schons, M D, St Paul
- Osteomyelitis of the Spine, with Case Reports J R McNutt, M D, Duluth
- The Radiation Therapy of Carcinoma of the Lip C O Hansen, M D, Minneapolis
- A Roentgenologic Consideration of the Normal Colon H M Weber, M D, Rochester
- The Roentgen Diagnosis of Placenta Previa W H Ude, M D, Minneapolis

Election of officers for the coming year resulted as follows: *President*, Robert G Allison, M D, Minneapolis, *Vice-president*, Eugene T Leddy, M D, Rochester, *Secretary*, *Treasurer*, Leo G Rigler, M D, Minneapolis.

The Russell Carman Memorial Lecture was inaugurated at this meeting before the general assembly of the Minnesota State Medical Association. Donald C Balfour, M D, of Rochester, delivered a splendid address on the life of Dr Russell D Carman and his contributions to radiology. B R Kirklin, M D, introduced A B Moore, M D, of Washington, D C, who presented an address on "The Function of the Roentgenologists in the Diagnosis of Abdominal Conditions." A similar lecture will be given each year at the meeting of the Minnesota State Medical Association.

ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J N ANÉ, M D , of New Orleans	HANS A JARRE, M D , of Detroit, Mich
J E HABBE, M D , of Milwaukee, Wis	ERNST A POHLE, M D , Ph D , of Madison, Wis

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LOUIS, and H. EARLE CONWELL, M.D., F.A.C.S., Orthopedic Surgeon for the Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama, Orthopedic Chief of the Traumatic and Orthopedic Services of the Employees' Hospital, Fairfield, Alabama, member of the Fracture Committee of the American College of Surgeons, and the Advisory Editorial Staff of "Journal of Bone and Joint Surgery." A volume of 1,164 pages, with 1,165 illustrations. Published by C. V. Mosby Company, St. Louis, 1934. Price, \$15.00.

The authors have produced a volume which covers the more modern methods of treatment of fractures of all types as well as some of the older methods. Their selection of material has been excellent and it is obviously collected from a wide experience in handling fractures in an up-to-date way. It is well organized and the material is presented in a clear and readable manner. The illustrations are well selected and in most instances adequately portray what the authors wish to convey. For the most part the treatment is well described as to all the satisfactory methods in use at the present time.

The references to the literature are in many cases inadequate and in some cases, we believe, misleading. This is perhaps of relatively little importance, and yet, in a reference book of this type, an adequate bibliography, well compiled, is a great help.

The authors have attempted to cover the causes and treatment of the industrial lame back, though we have failed to find any mention of the intervertebral discs in these cases. We believe their importance is worthy of more attention. While the authors mention fractures of the articular facets they have not stressed the importance of traumatic arthritis of these facets in the production of lumbosacral pain with or without sciatica. In another chapter they state that fractures of the sternum are rare. Thus we question, at least we believe that they are not so rare as indicated. We believe too that more emphasis should be placed on prophylactic administration of anti-gas serum than is found in the text.

In reviewing the work, however, it seems to have as few or fewer shortcomings than most such texts and it is modern and otherwise complete and should be in the hands of every one interested in the treatment of fractures.

LA NÉGATIVATION ÉLECTRIQUE By P. AUBOURG, Electro-radiologist of the Beaujou Hospital, C. LAVILLE, and P. LE GO. A volume of 146 pages. Masson et Cie, Paris, 1934. Price, 20 francs.

This monograph gives an account of the theoretical considerations leading to the construction of an apparatus called "electropulsator" by C. Laville, with a preliminary report concerning its clinical usefulness. No diagrams of the machine are shown in the text but it is stated that the type of electricity produced has not been employed before. Its three characteristics are set forth by the authors. Extremely small doses of current can be applied, it is possible to measure their order of magnitude with laboratory apparatus. Only the negative pole is utilized, therefore, the name of the procedure as well as the title of the book "Négativation Électrique." The pulsations are modulated, $1/e$, the ratio between the length of an impulse and the period between impulses is of the order of 1/9.

After an experimental study of the reflexes which may be produced by this new current the authors used it clinically with encouraging results in post-traumatic pain, in neuralgia and neuritis, in painful scars, and in glycosuria. The technical data were usually as follows: 9-12 volts, 70 interruptions per second. It is interesting to note that, for instance, a stomach which usually emptied in six hours, emptied in one and a half hours if this new current was applied to the seventh cervical segment of the spine. The frequency of the contractions was not changed but their strength seemed considerably augmented. The authors also state that 'in spite of the small quantities of electrical energy delivered by the apparatus, its therapeutic use can be compared to that of a powerful modifier of cellular metabolism.'

E. A. P.

valves and describe the radiographic technic used to visualize the lesion

The patient was a married woman, aged 52 years, who complained of occasional pains in the sternal region of twenty years' duration. Giddiness and shortness of breath at times also were noted by the patient. Physical examination revealed slight enlargement of the heart, a systolic thrill in the second right intercostal space, an apical systolic murmur and a faint diastolic murmur along the left border of the sternum. The radial and brachial arteries were thickened. The blood pressure was 170/130 mm Hg and the pulse rate was 68. The blood Wassermann reaction was negative. The clinical diagnosis was aortic stenosis with arteriosclerosis and hypertension.

Fluoroscopy revealed evidence of enlargement of the aortic arch. With the patient in a semi-oblique position a well marked comma shaped area of calcification was visible in the position of the aortic valve. The upper portion of the shadow appeared fixed and the lower end moved about a centimeter at each cardiac impulse. The shadow was noted in both oblique positions and also in the left lateral position.

In order to visualize calcification in the heart valves the authors advise adequate accommodation of the eyes and the use of a sufficiently small diaphragm. The radiographic demonstration is more difficult because of movement. A high milliamperage, a small cone, and a very short exposure time are suggested.

J N ANÉ, M D

Interatrial Septal Defect H Roesler Arch Int. Med., September 1934, 54, 339-380

A case is reported which illustrates the clinical and anatomic peculiarities of interatrial septal defects. Sixty two cases have been reviewed, including the author's. All of the cases of small defects or complete absence of the interatrial septum and combinations with patency of the ductus arteriosus, pulmonary stenosis, interventricular septal defect, and a high grade of coarctation of the aorta have been excluded.

In at least three fourths of all the cases valvular lesions were found which affected predominantly the mitral orifice. Subacute bacterial endocarditis did not occur, chronic pericardial disease, crossed embolism and tuberculosis of the lungs occurred rarely.

The roentgenologic findings were those of a large heart varying in shape from oval to globular, and extending as a rule, toward the left. The pulmonary conus and artery projected far to the left and upward and forward. The branches of the pulmonary artery (the hilum) at times showed increased pulsations and were sharply defined and enlarged. Lack of knowledge of the roentgenologic picture led to the erroneous diagnosis of mediastinal tumor or tuberculosis. The aortic knob was small—at times invisible. Other conditions which caused pulmonary dilatation and narrowness or absence of the aortic knob, were given.

The interesting finding from the electrocardiographic study was the presence as a rule of only a moderate

degree of axis deviation to the right. Enormous dilatation of the right side of the heart with comparatively moderate hypertrophy did not cause a high degree of right axis deviation in the electrocardiogram.

H A JARRE, M D

Coarctation or Congenital Stenosis of the Aorta Elizabeth Foley Taylor British Jour Radiol., August, 1934, 7, 452-462

Coarctation or congenital stenosis of the aorta in the region of the ductus arteriosus may be divided into the "infantile" and "adult" types. In the "infantile" type the aorta is narrowed where the ductus arteriosus joins this vessel. The "adult" type, in which there is complete stenosis or extreme narrowing, was described in 1828 and 1844 as postmortem curiosities. At the present time, this condition is recognized as a clinical entity which can be diagnosed radiologically.

Adult coarctation may produce no symptoms as long as the collateral circulation is sufficient to supply the needs of the body. However, with weakening of the myocardium as a result of intercurrent infection or increase in the hypertension in the upper parts of the body as a result of excessive muscular strain the condition may become evident between the ages of twenty and forty years.

Well-established cases of coarctation of the aorta may be recognized clinically. In the more obscure cases the radiological examination is considered of definite value in the diagnosis. The radiological findings in this condition are as follows: (1) In 75 per cent of the cases there is hypertrophy of the left ventricle, (2) the aortic knob is absent, (3) over 50 per cent of the cases show aneurysmal dilatation of the first portion of the aortic arch, (4) erosion of the under surfaces of the ribs is noted in nearly all cases, (5) the bifurcation of the trachea is noted "pencilled out" in the left oblique position due to the absence of the aortic shadow.

J N ANÉ, M D

KNEE JOINT

The Roentgen Diagnosis of Old Injury to the Cruciate Ligament of the Knee Joint F Felsenreich Fortschr a d Geb der Röntgenstrahlen, April, 1934, 49, 341-346

This paper is a careful roentgenologic study of the joint space at the knee and particularly the intercondylar eminences of the tibia. In an appreciable number of patients who have sustained injury to the knee joint one can later on detect evidence of trauma to the cruciate ligaments by changes in these intercondylar eminences and the adjacent fossæ, which represent chiefly proliferation of bone as an expression of the localized deforming osteo-arthritis. Such demonstrations seem to be of considerable judicial value.

H A JARRE, M D

Knee joint visualization A Roentgenographic Study with Iopax Douglas Boyd Jour Bone and Joint Surg., July, 1934, 16, 671-680

The author studied the x ray appearance of the visu-

Chronic Idiopathic Steatorrhea Roentgenologic Observations A. M. Snell and John D. Camp Arch. Int. Med., April, 1934, 53, 615-629

In this condition there are present deficient digestion and absorption of fat which may be attributed to some pancreatic disorder or to some intrinsic lesion of the duodenum or jejunum. The few available observations made at necropsy in these cases tend to substantiate this view. In cases reported by Whipple there were extensive deposits of neutral fat and fatty acids in the intestinal mucosa and in the mesentery and retroperitoneal lymph nodes. Chronic passive congestion and cloudy swelling of the viscera were also noted. In a case reported by Salvesen was found atrophy of the pancreas and spleen as well as parenchymatous degeneration of the liver. Such observations were also confirmed by other writers.

On the basis of these anatomic observations it would appear that, in certain cases at least, it should be possible to demonstrate roentgenologically evidence of disease in the upper part of the intestinal tract, and certain changes have been noted in three of the seven cases reported. The roentgenologic findings consisted of delayed motility and alterations in the mucosal relief of the small intestine, especially the jejunum, producing a smoothing of the contours of the lumen, obliteration of the usual markings of the valvulae conniventes, and clumping of the barium in elongated masses. These roentgenologic findings suggested an inflammatory condition with edema of the mucosa and infiltration of the walls involving especially the small intestine and occasionally the stomach, duodenum, and colon. The regression of the changes coincident with the improvement in the clinical symptoms, and inflammatory changes described at necropsy in similar cases would seem to substantiate the correctness of the observations. It is not held that these roentgenologic observations are characteristic only of chronic idiopathic steatorrhea, since they may occur in varying degrees of any acute inflammatory condition of the intestinal tract. Their presence however constitutes tangible evidence during life of alterations in the gastro intestinal tract which has been suspected clinically and found at necropsy in idiopathic steatorrhea.

This paper and the disease syndrome it describes is important to the roentgenologist because it throws additional light on diseases of disturbed mineral metabolism. In connection with the paper it is noted that three of seven cases discussed presented changes in the skeletal system especially one case of osteoporosis and a second case with marked osteomalacia including deformities of the pelvis and long bones and pseudo-fractures.

From the anatomic physiologic and roentgenologic evidence presented it is apparent that the clinical syndrome of idiopathic steatorrhea with tetany may be produced by an inflammatory or atrophic lesion of the upper intestinal segments. The element of defective absorption of fat, mineral salts and vitamins may well be secondary to such lesions. The condition undoubtedly does not constitute a clinical entity. The same

clinical phenomena have been encountered in tropical sprue, which, at recent studies seem to indicate may be a deficiency disease approximating in some respects primary anemia.

H. A. JARRE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

The Diagnostic Significance of Pyelovenous Reflux. R. Töppner Fortschr. a. d. Geb. d. Röntgenstrahlen, September, 1934 50, 281-286

Two cases of so-called pyelovenous reflux are reported. No pathognomonic significance is attached to such observations beyond the indication of a pathologically increased pressure in the renal pelvis which might have been produced by spasm, ureteral occlusion, or faulty injection.

H. A. JARRE, M.D.

HEART AND VASCULAR SYSTEM

The Roentgenologic Diagnosis of Intracardiac Calcifications. Paul A. Bishop and Hugo Roesler. Am. Jour. Roentgenol. and Rad. Ther. January 1934, 31, 1-15

Calcareous deposits in some portion of the heart are rather common in individuals over fifty years of age but are often only microscopically visible, or are so scattered as to escape detection by both ordinary and special roentgen examination. When readily visible with the naked eye, they may then often be successfully studied *in vivo* or postmortem by appropriate roentgenologic methods. In the authors' article the term "intracardiac calcification" is restricted to calcification of the left annulus fibrosis and mitral and aortic valves. Roentgenoscopy is an important part of the study for the character and extent of the movements of these areas of calcification and is very helpful in determining their structural location. An elliptical "dancing" or "jerking" motion, varying in speed and covering a distance of 0.8 to 1.5 cm., is described as characteristic. It is the authors' belief that such changes are more often on a degenerative rather than an inflammatory basis (fatty degeneration, necrosis, atheroma, calcification), of the skeletal connective tissue of the heart which is interposed between atria and ventricles and serves for insertion of atrioventricular valves, aorta and pulmonary artery.

For radiographic demonstration a Rotalix tube is preferred which allows rapid exposure and gives fine detail. The pre- and postmortem radiographic appearances of the three cases reported are included in the illustrations.

J. E. HABBE, M.D.

Radiography of Calcification in Cardiac Valves during Life. J. V. Sparks and Courtenay Evans. British Jour. Radiol. August 1934 7, 463-466

The authors discuss the clinical examination and radiologic demonstration of calcification in the heart.

complete critical review of the literature concerning the subject. In this review it is especially pointed out that in older reports quite frequently a differentiation between the effects of irradiation and primary disease for which irradiation was employed is not possible, that furthermore, dosimetric data frequently are quite defective. A case is then reported of true limitation of growth of bone by roentgen irradiation in early youth, producing simultaneously marked failure of development of the female mammary gland. This case is particularly remarkable because it demonstrates clearly limitation of bony growth by roentgen irradiation without primary underlying bony disease. It is pointed out in the paper, furthermore, that during irradiation of young children the possibility of the production of defective growth must be kept in mind and that particular caution is necessary with the dosage to be applied. One must be particularly cautious with indications for x-ray therapy during the first three years of life, though in serious conditions well directed roentgen treatment even with heavy dosage, may be come necessary to save a child's life at the risk of later deformity.

H. A. JARRE, M.D.

THE SKULL (DIAGNOSIS)

Deformation of the Sella Turcica in Tumors of the Middle Cranial Fossa. Karl Kornblum. *Am Jour Roentgenol and Rad Ther*, January, 1934, 31, 23-30.

Using a previously suggested classification of intracranial newgrowths not arising from within the pituitary fossa, into the three groups, (a) suprasellar, (b) parasellar, (c) metasellar, the writer reviews 40 verified cases of tumor occurring in the middle cranial fossa (parasellar), to determine the frequency of sufficiently characteristic sella changes to correctly classify them as falling into the parasellar group. Thirty-four (or 85 per cent) of the series showed sellar deformation while only 12 cases (or 30 per cent) showed other roentgenologic signs of tumor (most commonly calcification). Sellar changes most commonly seen in the parasellar group are: (1) erosion of dorsum manifested by indistinctness of structure, (2) intact but indistinct posterior clinoids, (3) slight enlargement of the fossa (often only top limits of normal), these erosive changes being regularly unilateral and often best demonstrated by films taken with the head in a position slightly oblique from the true lateral.

The most helpful single clinical finding taken in conjunction with the above-described x-ray changes, is a homonymous hemianopsia, with a varying degree of motor weakness.

J. E. HADDE, M.D.

THE SPINE

Non tuberculous Infections of the Spine. Armitage Whitman and Raymond W. Lewis. *Jour Bone and Joint Surg*, July, 1934, 16, 587-593.

While tuberculosis and chronic osteo arthritis of the spine may be recognized by their roentgenographic appearance, other known types of infection of the spine

such as osteomyelitis, typhoid arthritis, syphilis, Neisserian infection, fungus infections, undulant fever, and unclassified infectious arthritis are differentiated roentgenographically and clinically only with difficulty and uncertainty. The authors report a series of four cases of such non-tuberculous spine infections.

Case 1, a woman of middle age, presented a history of an abrupt onset of pain in the back eighteen months before. For the next four to seven weeks she was ill with what was called intestinal influenza. Although she enjoyed some comfort after the subsidence of her intestinal condition, for several months, following a motor trip, she again experienced pain and stiffness in the back, which increased in severity. Under general anesthesia, her spine was placed in proper alignment and a plaster jacket was applied. About two years following this treatment roentgenograms revealed a destruction of the discs between the second and the third and also between the fourth and the fifth lumbar vertebral bodies, with bony bridging between the adjacent margins of these vertebrae. This case was believed to belong to the class of infectious arthritis, following intestinal influenza or to the osteomyelitis group.

Case 2, a woman, aged 29 years, complained of pain in the dorsal region of one year's duration. There was no history of injury. Roentgenographic examination showed narrowing of the intervertebral disc between the fifth and sixth dorsal vertebral bodies. The most likely diagnosis of this case was believed to be unclassified infectious arthritis.

Case 3, a man, aged 20 years, complained of pain in the lumbosacral region of two months' duration. There was no known etiology except over-exertion brought about by lifting stones at a summer camp. No constitutional symptoms were noted. Roentgenographic examination showed a rounded area of bone destruction and bone production at the superior anterior margin of the body of the third lumbar vertebra with considerable narrowing of the disc between the second and third vertebral bodies. A plaster jacket was applied and examination one year later showed a filling in with new bone of the area of bone destruction in the third lumbar body. This case was believed to be a case of low-grade pyogenic abscess of a vertebral body with involvement of the intervertebral disc.

Case 4, a man, aged 22 years, presented a history of four discharging sinuses in the following locations: Left groin, lumbosacral region, over the right hip, and over the right sacro-iliac region. Eight years previously he had had many boils. His illness began with high temperature and severe pain in the small of the back. Repeated smears, cultures, and guinea-pig inoculations failed to reveal the presence of tuberculosis. X-ray examination after injection of the sinuses with a 12 per cent solution of sodium iodide showed that the sinuses led down to the right fifth transverse process and to the right of the bodies of the fourth and fifth lumbar vertebrae. Narrowing of the intervertebral disc between the fourth and fifth bodies with roughening of the adjacent surfaces of the bodies and

alized knee-joints of seven patients after the injection of the articular spaces with iopax solution. Michaëlis in 1931, employed iopax in a similar study. However, his patients were kept in bed, under observation, for one or two days, whereas, the author's series consisted of ambulatory patients only.

In this study the patients were taken directly to the x-ray department without previous preparation. The solution used was an autoclaved 30 per cent iopax, dissolved in 0.5 per cent novocain. The injection was made with surgical aseptic technic directly into the suprapatellar pouch, from the lateral aspect of the joint at the level of the superior border of the patella. If effusion was present, this fluid was first aspirated before the injection. If no fluid was present in the joint, salt solution was first injected and withdrawn to make certain of the position of the needle, after which the iopax solution was injected. Roentgenograms were then taken. The leg was then manipulated through its full range of motion and additional films were made with the leg in flexion. After the roentgenograms had been taken as much of the solution as possible was withdrawn. The puncture site was then dressed and an elastic bandage was placed over the joint. Rest in bed for a period of 48 hours and heat to the joint was prescribed. It was determined that from 25 to 35 c.c. of the solution was sufficient for good shadows.

The following conditions of the knee joint were studied by this method: villous synovitis, hypertrophic arthritis, Charcot joint, infectious arthritis and popliteal bursitis. No unfavorable reactions were noted in any case. Of interest also is the fact that three patients were relieved of previous joint pain and effusion.

It is believed that with further study of the x-ray appearance of the visualized knee joint this method will prove of diagnostic value and that it may even yield therapeutic results. The procedure was without danger as used by the author and, while the solution produced a hyperemia of the synovial membrane, no cellular exudate was observed.

J. N. ANÉ, M.D.

PARATHYROIDISM

Hyperparathyroidism Due to Diffuse Hyperplasia of All Parathyroid Glands Rather Than Adenoma of One (Clinical Studies of Three Such Cases) F. Albright, E. Bloomberg, B. Castleman, and E. D. Churchill. *Arch. Int. Med.*, September 1934, 54, 315-329.

Three patients with clinical hyperparathyroidism were found at operation to have multiple parathyroid enlargements considered to represent hyperplasia of all parathyroid tissue. The authors state that they attach no significance to the fact that none of their three patients had bone disease. They consider this a complication of the disease dependent on duration, degree, and dietary habits rather than a necessary feature. The metabolic findings were typical of hyperparathyroidism. The data for the urinary excretion of cal-

cium and phosphorus were not given, but very large amounts were excreted by patients for whom these values were determined.

The histologic structure of the glands in these patients differed markedly from that in 16 cases from the clinic in whom only solitary parathyroid enlargements were present. The distinctive features were the uniformity of structure, the enormous size of the cells, the extreme clearness of the cytoplasm, and the tendency to glandular formation.

A distinction is made between parathyroid hyperplasia with hyperparathyroidism and compensatory hyperplasia of the parathyroid glands. An analogy between the former and exophthalmic goiter is made.

Hyperplasia of the parathyroid glands with hyperparathyroidism is considered a disease entity.

The surgical treatment of parathyroid hyperplasia with hyperparathyroidism brings up some interesting questions. Thus removal of two enlarged glands in one of these patients was without effect on the serum calcium and inorganic phosphorus levels. Even with removal of sufficient tissue to alter the blood chemistry satisfactorily, the condition is apt to recur. It is still undecided whether this condition can be handled by surgical means.

A review of 101 cases of hyperparathyroidism revealed 17 cases, including these three, in which there were multiple parathyroid enlargements. Several are undoubtedly similar to the ones here reported. The records of the cases of multiple parathyroid tumors have abundant circumstantial evidence in them to suggest that the pituitary gland is incriminated. The cause of the hyperplasia is probably a parathyroid stimulating factor, possibly the one of the anterior lobe of the pituitary described by Hertz and Krancs.

H. A. JARRE, M.D.

RADIATION EFFECTS

The Effects of Roentgen Irradiation upon Carriers and Excretors of Diphtheria Bacilli E. D. Dubowyn, N. A. Grnberg, M. T. Prodan, and O. W. Gefter. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, September, 1934, 50, 294-299.

Irradiation of the pharynx and tonsils with from 20 to 35 per cent of an erythema dose at 210 KV, 0.05 mm. aluminum, is reported to have rendered most of these individuals free from bacilli within a week's time.

(The paper undoubtedly is open to much discussion and criticism in spite of quotations from several American authors—Hickey, Witherbee, and others.)

H. A. JARRE, M.D.

ROENTGEN-RAY THERAPY

Concerning Disturbance of Bony Growth and Retardation of Development of the Female Mammary Gland as a Result of Roentgen Irradiation during Infancy and Childhood G. F. Haenisch. *Fortschr. a. d. Geb. der Röntgenstrahlen*, July 1934, 50, 78-86.

This paper by the well known author first gives a

complete critical review of the literature concerning the subject. In this review it is especially pointed out that in older reports quite frequently a differentiation between the effects of irradiation and primary disease for which irradiation was employed is not possible, that furthermore, dosimetric data frequently are quite defective. A case is then reported of true limitation of growth of bone by roentgen irradiation in early youth, producing simultaneously marked failure of development of the female mammary gland. This case is particularly remarkable because it demonstrates clearly limitation of bony growth by roentgen irradiation without primary underlying bony disease. It is pointed out in the paper, furthermore, that during irradiation of young children the possibility of the production of defective growth must be kept in mind and that particular caution is necessary with the dosage to be applied. One must be particularly cautious with indications for x ray therapy during the first three years of life, though in serious conditions well directed roentgen treatment, even with heavy dosage, may become necessary to save a child's life at the risk of later deformity.

H. A. JARRE, M. D.

THE SKULL (DIAGNOSIS)

Deformation of the Sella Turcica in Tumors of the Middle Cranial Fossa. Karl Kornblum. *Am Jour Roentgenol and Rad Ther*, January, 1934, 31, 23-30.

Using a previously suggested classification of intracranial newgrowths not arising from within the pituitary fossa, into the three groups, (a) suprasellar, (b) parasellar, (c) metasellar, the writer reviews 40 verified cases of tumor occurring in the middle cranial fossa (parasellar), to determine the frequency of sufficiently characteristic sella changes to correctly classify them as falling into the parasellar group. Thirty four (or 85 per cent) of the series showed sellar deformation while only 12 cases (or 30 per cent) showed other roentgenologic signs of tumor (most commonly calcification). Sellar changes most commonly seen in the parasellar group are: (1) erosion of dorsum manifested by indistinctness of structure, (2) intact but indistinct posterior clinoids, (3) slight enlargement of the fossa (often only top limits of normal), these erosive changes being regularly unilateral and often best demonstrated by films taken with the head in a position slightly oblique from the true lateral.

The most helpful single clinical finding taken in conjunction with the above described x ray changes, is a homonymous hemianopsia, with a varying degree of motor weakness.

J. C. HADDE, M. D.

THE SPINE

Non tuberculous Infections of the Spine. Armitage Whitman and Raymond W. Lewis. *Jour Bone and Joint Surg*, July, 1934, 16, 557-593.

While tuberculosis and chronic osteo arthritis of the spine may be recognized by their roentgenographic appearance, other known types of infection of the spine

such as osteomyelitis, typhoid arthritis, syphilis, Neisserian infection, fungus infections, undulant fever, and unclassified infectious arthritis are differentiated roentgenographically and clinically only with difficulty and uncertainty. The authors report a series of four cases of such non tuberculous spine infections.

Case 1, a woman of middle age, presented a history of an abrupt onset of pain in the back eighteen months before. For the next four to seven weeks she was ill with what was called intestinal influenza. Although she enjoyed some comfort after the subsidence of her intestinal condition, for several months, following a motor trip, she again experienced pain and stiffness in the back, which increased in severity. Under general anesthesia, her spine was placed in proper alignment and a plaster jacket was applied. About two years following this treatment roentgenograms revealed a destruction of the discs between the second and the third and also between the fourth and the fifth lumbar vertebral bodies, with bony bridging between the adjacent margins of these vertebrae. This case was believed to belong to the class of infectious arthritis, following intestinal influenza or to the osteomyelitis group.

Case 2, a woman, aged 29 years, complained of pain in the dorsal region of one year's duration. There was no history of injury. Roentgenographic examination showed narrowing of the intervertebral disc between the fifth and sixth dorsal vertebral bodies. The most likely diagnosis of this case was believed to be unclassified infectious arthritis.

Case 3, a man, aged 20 years, complained of pain in the lumbosacral region of two months' duration. There was no known etiology except over-exertion brought about by lifting stones at a summer camp. No constitutional symptoms were noted. Roentgenographic examination showed a rounded area of bone destruction and bone production at the superior anterior margin of the body of the third lumbar vertebra, with considerable narrowing of the disc between the second and third vertebral bodies. A plaster jacket was applied and examination one year later showed a filling in with new bone of the area of bone destruction in the third lumbar body. This case was believed to be a case of low grade pyogenic abscess of a vertebral body with involvement of the intervertebral disc.

Case 4, a man, aged 22 years, presented a history of four discharging sinuses in the following locations: Left groin, lumbosacral region over the right hip, and over the right sacro iliac region. Eight years previously he had had many boils. His illness began with high temperature and severe pain in the small of the back. Repeated smears, cultures and guinea pig inoculations failed to reveal the presence of tuberculosis. X ray examination after injection of the sinuses with a 12 per cent solution of sodium iodide showed that the sinuses led down to the right fifth transverse process and to the right of the bodies of the fourth and fifth lumbar vertebrae. Narrowing of the intervertebral disc between the fourth and fifth bodies with roughening of the adjacent surfaces of the bodies and

erosion of the right transverse process of the fifth lumbar vertebra with sequestrum formation were also noted. Because of the exclusion of tuberculosis and the history of boils this case was believed a chronic non-tuberculous osteomyelitis and arthritis of the spine.

J N ANÉ, M D

Chronic Rheumatic Diseases of the Spine. J L Miller. Arch Int Med, August, 1934, 54, 161-169.

The two types of chronic rheumatism seen in the extremities may also affect the spine. Rheumatoid arthritis of the spine may be followed by pathologic changes recognized as spondylitis ankylopoietica. The cause of the early and frequent incidents of osteo-arthritis of the spine is discussed. Extensive reference is made to the investigations and publications by German authors, especially G. Schmorl and H. Junghans (In "Die gesunde und kranke Wirbelsäule im Röntgenbild," Leipzig, Georg Thieme, 1932, where a complete bibliography on chronic rheumatism of the spine may be found).

H A JARRE, M D

THE STOMACH

Thoracic Stomach. H W Goodall and L H Hoyt. Arch Int Med, April, 1934, 53, 594-614.

Report of five cases, three of which carried the greater part of the stomach above the diaphragm, two only small cardiac segments. The authors draw attention to the relative shortness of the esophagus, which configuration they consider to be of etiologic importance. The viewpoint of the writers and their deductions are open to much criticism.

H A JARRE, M D

SYMPHYSIS PUBIS

Adolescent Osteochondritis of the Symphysis Pubis, with a Consideration of the Normal Roentgenographic Changes in the Symphysis Pubis. Michael Burman, Isaac Newton Weinkle, and Maurice J. Langsam. Jour Bone and Joint Surg, July, 1934, 16, 649-657.

The authors report the case of a young man, 17 years of age, who was pinned between a slowly moving auto truck and a fence. Examination after the accident revealed tenderness only over the lower part of the right rectus abdominis and pyramidalis muscles. No tenderness over the bony parts of the symphysis pubis was noted. The treatment consisted of rest in bed with an ice bag over the lower abdomen and in a period of two weeks he was entirely symptom free. He remained entirely well until slightly over four months from his injury at which time he experienced a dull dragging pain in the region of the symphysis pubis. Roentgenographic examination showed an irregular woolly appearance of the symphysis pubis with an excess of the mammillation frequently noted at this period. The pain gradually disappeared under treatment, and about one month later stereoroentgenograms of the symphysis showed an advance in the disease process. Although symptom free at this

time treatment was continued. Approximately five months later the patient was examined and stereoroentgenograms at this time revealed that the symphysis was much smoother.

The authors studied the normal roentgenographic appearance of the symphysis pubis in a series of 127 patients, of both sexes and of various ages. It was noted that in the very young the symphysis is broad and flares outward above and below. The ischio-pubic junction does not join until the age of four years. While this region may show two or three areas of vacuolation, bordered by a line of condensation, it is considered normal for this age period and not a sign of osteochondritis. From the tenth year on, the symphysis pubis often shows horizontal grooving or mammillation, which is more manifest in the earlier years of the second decade. Toward the age of twenty years, the edges of the symphysis pubis become smooth, are more vertically placed, and approach the adult type. In the third decade mammillation or grooving is no longer seen, and the symphysis measures about one eighth of an inch. From 45 to 60 years of age the interspace of the symphysis is reduced and measures less than one-eighth of an inch. From 60 to 75 years of age an increase in the flaring and narrowing is noted.

J N ANÉ, M D

THORAX

Roentgenological Examination of the Chest in Lateral Decubitus. Samuel Brown. Am Jour Roentgenol and Rad Ther, January, 1934, 31, 41-43.

The writer has tested the value of the chest examination in the lateral decubitus position (after the method of Rigler, described by that author in 1931), and finds that in some instances especially in cases in which there is considerable fluid present, the lateral decubitus position with the affected side up may afford valuable diagnostic information not found otherwise. An especially good example illustrated by the author was that of a case of endothelioma arising from the lower axilla, the tumor shadows being visualized only in the lateral decubitus affected side up. A simple apparatus for elevating the patient above the table and for supporting the cassette is described and illustrated.

J E HABBE, M D

TUBERCULOSIS OF BONES

Tuberculosis of the Shaft of the Large Long Bones of the Extremities. C K. Hsieh, Leo J. Milner, and C P. Chang. Jour Bone and Joint Surg, July 1934, 16, 545-563.

Tuberculosis of the shaft of the large long bones of the extremities has been classified by the authors into four types according to the roentgenographic appearance.

Type I or 'Tuberculous Periostitis' is considered the rarest form of shaft tuberculosis. It is characterized by a rarefied laminated, periosteal proliferation with no involvement of the underlying cortex.

Type II is known as the 'Solitary Tuberculous Abscess (Brodie's Type)' and consists of a single area of destruction, usually located centrally in or near the metaphysis. While in the early stages no change is noted in the surrounding bone, in the later stages condensation usually occurs around the periphery of the lesion and sequestra may be present. Late in the course of the disease with involvement of the neighboring bone by direct extension, it may be impossible to distinguish this type from Type III.

In Type III, or "Localized Tuberculous Osteomyelitis" the involvement of the shaft is more extensive. In the early stages of the disease, the medullary and cortical portions of the bone appear hazy, and scattered rarefied areas of destruction are noted. Later a certain amount of involucrum may be noted which may be similar to that found in pyogenic osteomyelitis, especially after the formation of sinuses and the addition of secondary infection.

Type IV, which is designated as 'Massive Tuberculous Osteomyelitis,' shows in the early stages marked decalcification of the shaft usually with a fusiform swelling of the periosteum and surrounding soft tissue. Since the circulation of the periosteum is not seriously involved laminated layers of involucrum may be seen after several weeks or months.

The authors noted in the series of 20 cases which they report that in the majority of these cases the onset was insidious and the course chronic. Pain of a dull aching character and muscle spasm were present for several days or weeks, following which soft-tissue swellings developed gradually. A slight febrile reaction, general malaise, and a slight loss in weight were noted in these cases. The abscesses were not usually of the "cold" type but formed directly over the diseased areas of the bone and tended to rupture spontaneously after several weeks. This form of tuberculous infection could be differentiated from pyogenic osteomyelitis in that the onset was less acute, the pain less severe, and the febrile reaction was less pronounced.

It was found advisable in studying this condition to obtain roentgenograms of the lungs in every case of tuberculosis of the bone, for it was noted that patients with shaft tuberculosis and active pulmonary lesions did not usually respond favorably to treatment. On the other hand, approximately 75 per cent of the uncomplicated cases of shaft tuberculosis responded favorably following the usual orthopedic care.

The treatment of the closed lesions consisted of the unroofing of the diseased area of the bone and the excision of as much as possible of the diseased bone and soft tissue. The open cases were treated in the same manner as the ordinary case of osteomyelitis.

J N ANÉ, M D

TUMORS (DIAGNOSIS)

Osteoid tissue forming Tumor Simulating Annular Sequestrum. Henry Milch. *Jour Bone and Joint Surg.* July 1934, 16, 681-688.

In 1930, Hitzrot reported the case of a woman who presented a painful and swollen wrist which on roentgenographic examination revealed an unusual involvement of the carpal scaphoid. The lesion appeared as a decalcified area, containing a very dense piece of bone. The entire area was surrounded by an annular shadow of sclerosed bone. The author presents four additional cases with similar history, clinical findings, roentgenographic examination, and histologic study, and he believes that all five cases should be classified as benign osteoblastic osteoid-tissue forming tumors.

The characteristic findings in these cases were pain, swelling, and roentgenographic evidence of involved bone. The pain is described as constant, of a dull, boring character, worse at night and after exertion. The swelling is localized to the involved region. Since these signs are common to many conditions the roentgenogram alone is considered diagnostic of the lesion.

While the roentgenographic appearance may seem similar to that of an annular sequestrum lying free in a cavity, closer observation shows that the lesion is made up of several parts. In the early stages the central area is quite uniformly dense but in the later stages this central portion appears to be subdivided into a peripheral annular zone of radio-opacity, surrounding a central lighter area which may represent the site of tumor necrosis. Beyond this central area there is noted an area of radiotranslucency which is traversed by radially arranged opaque striations, which seem to unite the central area with the surrounding bone. This is believed to be the bone of the osteoid tissue which is relatively translucent to the x-rays. The entire lesion may be sharply demarcated by a dense circular shadow from the normal bone or the surrounding tissues may reveal a reactive process.

Although three of the five cases presented gave a history of trauma, because of the considerable variation in the lapse of time following injury as compared to the development of the lesion, the author is of the opinion that injury is not related to the development of the tumor. The treatment of this condition consists of the complete eradication of the tumor.

J N ANÉ, M D

THE UTERUS

Results of Radiation Therapy in Carcinoma of the Uterus Treated from 1926 to 1931. W. Dieterich and A. Edinger. *Strahlentherapie* 1934, 50, 557-565.

The authors compiled statistics of the results obtained by radiation therapy in uterine cancer. A total of 237 cases treated from 1926 to 1931 could be traced. Combined x-ray and radium therapy appeared to be the most efficient method. Usually a total of from 5,000 to 6,000 mgh was applied (10-15 mm brass). The distribution of the screens of 10 mg each and the settings depended on the needs of the individual case. Roentgen technic: 180 K.V., 3-4 ma, 0.5 mm Cu H.V.L. in Cu 0.9 mm, 40 cm F.S.D. 10 X 15 or

20 X 20 cm field size not more than 360 r (in air) per sitting, 1-2 fields per day, total of 600-720 r effective in the tumor. Of the entire material 89 (or 37.59 per cent) were alive on April 1, 1934. A series of tables is presented permitting an analysis of the results in more detail. It is encouraging to note that of 124 inoperable carcinomas of the cervix, treated by irradiation, 19.6 per cent were alive at the time of the report. Thorough and prolonged follow up examinations of these patients are most essential.

ERNST A. POHLE, M.D., Ph.D.

The Primary Morbidity and Mortality of Intensive Therapy of Carcinoma of the Cervix. Hemz Kirchoff and J. Drenckhahn. *Strahlentherapie*, 1934, 50, 428-445.

The primary morbidity and mortality was studied in 924 cases of carcinoma of the cervix observed during 1922-33. 401 cases were operated on, 459 cases treated by radium, and 64 were incurable. The primary mortality of the radium cases was 3.9 per cent, no complications occurred in 60.3 per cent, slight complications in 24.4 per cent, and serious complications in 9.2 per cent. The primary mortality of the operation amounted to 8.72 per cent with a higher mortality of the Wertheim operation over the Schauta operation. No complications occurred in 62.5 per cent, slight complications in 13.2 per cent, and severe complications in 13.7 per cent. A short paragraph is devoted to the precautions to be observed in order to avoid fistula.

ERNST A. POHLE, M.D., Ph.D.

The Selective Treatment of Carcinoma of the Cervix. M. Bolaffio. *Strahlentherapie*, 1934, 50, 566-575.

The author, who is professor of gynecology and ob-

stetrics at the University of Modena (Italy) advocates a combination of operation and irradiation in the treatment of carcinoma of the cervix. He feels that radical removal of the cervical growth offers the best guarantee for a permanent local cure. It is necessary, however, to carefully select early cases or to reduce the size of the involvement by pre-operative radium treatment. Neither irradiation nor operation guarantees the prevention of recurrence and distant metastases. In cases in which operation is planned, not more than from 3,000 to 4,000 mgh. should be applied in the cervix. In the inoperable cases, doses up to 7,000 mgh. applied within one week are indicated. If these cases do not become operable within one month, additional radium therapy may be given up to a total dose of 8,000 mgh., fractional roentgen therapy being applied in both instances. X-ray therapy is also given after operation.

The author concludes that his preliminary results of the combined treatment, namely operation, pre-operative radium therapy, and post-operative x-ray therapy are better than those of irradiation alone.

ERNST A. POHLE, M.D., Ph.D.

Further Results of Radiation Therapy in Uterine Carcinoma. Friedrich Voltz. *Strahlentherapie*, 1934, 50, 576-578.

In 1931 the author published statistics showing the end results obtained by radiation therapy in uterine carcinoma. He presents now the same figures brought up to date. It may be mentioned that during 1927 and 1928 316 women with carcinoma of the cervix were treated by irradiation, of whom 24 per cent were alive and well after five years. In the same period, 31 cases of carcinoma of the fundus were treated by irradiation, 11 of these being well five years later.

ERNST A. POHLE, M.D., Ph.D.

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ANOMALIES OF THE COLON THEIR ROENTGEN DIAGNOSIS AND CLINICAL SIGNIFICANCE¹

RÉSUMÉ OF TEN YEARS' STUDY¹

By JOHN L. KANTOR, M.D., *New York City*

THIS study is based on a series of approximately 2,000 consecutive cases in which the form and function of the colon was observed roentgenologically. This series, in turn, constitutes a part of a basic group of approximately 4,000 private patients complaining of various digestive symptoms, thus furnishing a homogeneous background for the conclusions presented. The statistical method was employed throughout in the belief that this would yield results most likely to be objective in nature and most open to confirmation or refutation by others.

By way of preliminary survey 3,000 unselected cases of the basic group were analyzed for the general incidence of the more common symptoms of "indigestion." These figures are presented in Table I, and will be used throughout the paper as a standard of comparison for the anomalies about to be described. Having no preconceived notions to establish, the chief emphasis will be placed on the facts themselves, leaving the temptation to speculate on their significance in the background. Nevertheless, before proceeding to details it may be of value to formulate the following generalizations that have grown out of this study:

1. Anomalies may be regarded as expressions of organic constitutional inferior-

TABLE I—INCIDENCE OF THE MORE COMMON COMPLAINTS OF DYSPEPTICS BASED ON 3,000 HISTORIES

	Per cent
1 Abdominal pain	47.7
2 Constipation	46.5
3 Flatulence	37.8
4 Belching	33.6
5 Headache	23.3
6 Vomiting	19.9
7 Epigastric Distress	13.8
8 Abdominal Distention	12.7
9 Heartburn	11.2
10 Right Lower Quadrant Pain (in 1,691 x-rayed cases)	9.5
11 Nausea	9.1
12 Diarrhea	8.6
13 Food Restriction	7.8
14 Anorexia	6.0
15 Regurgitation	3.9
16 Globus Hystericus	3.2
17 Vertigo	3.1
18 Jaundice	3.1
19 Bleeding (Hematemesis 38, melena 30)	2.3
20 Bleeding (Bright blood in stools)	2.3

ity or, in other words, points of actual or potential weakness in the body structure.

2. Anomalies may be divided into the following three classes: Those incompatible with life (congenital atresia of the bile ducts), those compatible with life but not with robust health (high grade visceroptosis), those compatible with life and health under favorable circumstances (uncomplicated Meckel's diverticulum).

3. The general tendency seems to be for the body as a whole to compensate for the presence of an anomaly. Hence symp-

¹ Read before the Fourth International Congress of Radiology, Zürich, July 28, 1934.

toms do not occur unless this compensatory mechanism breaks down, a break which may result from any of the following causes

obligation to cause symptoms in all of their owners all of the time. This is the chief single differential between an anomaly and an acquired lesion and is of great im-

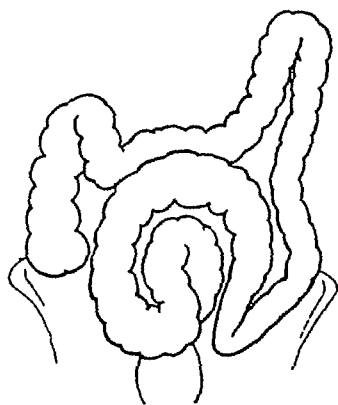


Fig 1 Redundant colon
Large central pelvic loop, rising well above inter iliac crest level (basic criterion)

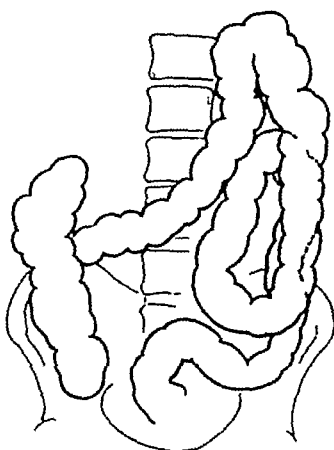


Fig 2 Redundant colon
Complete loop of iliac portion

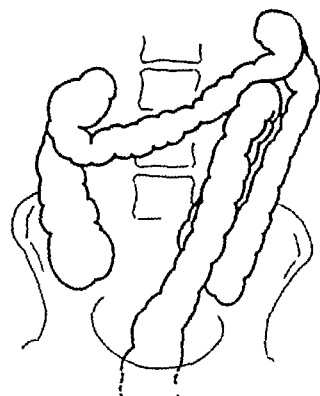


Fig 3 Redundant colon
Double splenic flexure with straight efferent loop

(a) Mechanical factors, such as strangulation of a silent Meckel's diverticulum

(b) Infection, which may change a diverticulosis into a diverticulitis

(c) Juxtaposition of two or more anomalies, such as the presence of ectopic gastric mucosa in a Meckel's diverticulum, which may lead to hemorrhage or perforation

(d) Old age and increasing asthenia especially prominent in the case of all hernias and herniations, in which the weak spots exist from birth but the fully developed condition occurs later in life

(e) Associated functional instability. When neuroses and anomalies co-exist, the former furnishes the underlying functional instability—the break in compensation—and the anomaly furnishes the particular digestive symptomatology for the clinical picture

4 Because of variations in the compensatory mechanism, the symptomatology of anomalies is not continuous or progressive as in ordinary diseases. Thus, anomalies may cause symptoms in some of their owners all of the time, and in all of their owners some of the time, but are under no

portance in appraising the practical significance of anomalies

Anomalies of the colon will be discussed under the following headings

Anomalies of length Redundant colon

Anomalies of rotation Non-rotation

Anomalies of descent Hypodescent, hyperdescent

Anomalies of fixation Hypofixation, hyperfixation

ANOMALIES OF LENGTH REDUNDANT COLON (DOLICHOCOLON)

Description and Roentgen Appearance—The redundant colon (dolichocolon) is one which is too long to fit into the body of its owner without undergoing reduplication. The distal colon is the part usually though not invariably affected, the most common variety being an enlarged sigmoid loop centrally placed and rising well out of the pelvis (Fig 1). Redundancy of the iliac colon is also frequent (Fig 2). Two sub-varieties are encountered often enough to receive the descriptive terms "double splenic flexure with straight efferent loop" (Fig 3) and "pelvic loop to the right" (Fig 4). Kinks of the colon, presumably

due to bands or adhesions, are rather frequent. Of these, 166 cases were encountered in our series but have been excluded from the group of true redundant

termed "cascade" stomach. In some cases the stomach is inverted or rotated on its horizontal axis so that it becomes retort-shaped

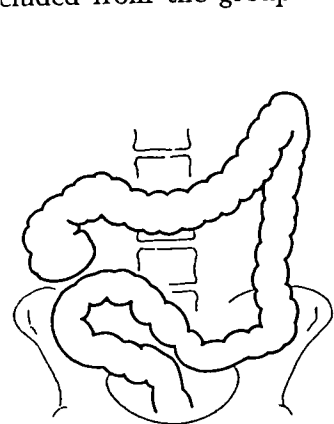


Fig 4 Redundant colon
Pelvic loop to right

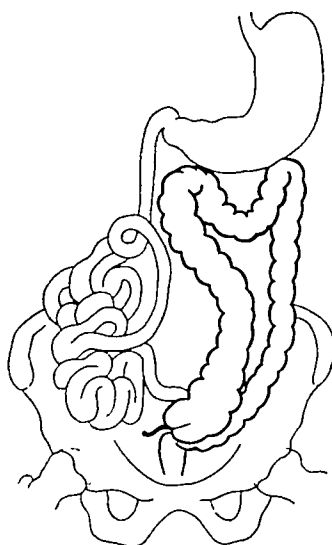


Fig 5 Non rotated colon
Showing ectopic small intestine
with ileum entering colon from the
right

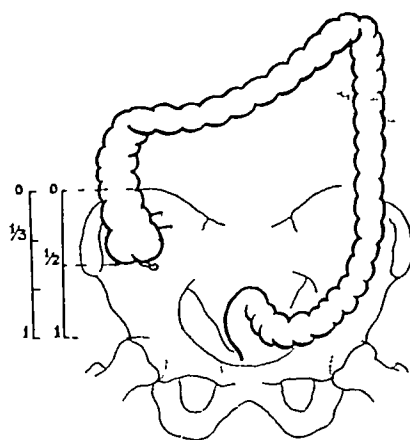


Fig 6 Normal colon
Showing roentgen landmarks

colons and are not here discussed. Hirschsprung's disease (not discussed in this paper) differs from the redundant colon by the presence of enormous dilatation of the affected loops in the former.

The diagnosis of redundant colon is made by roentgen examination after the opaque enema to show the form, and after the opaque meal to show the function, of the large intestine. The opaque enema is the basic procedure. Any case in which the enema-filled pelvic loop rises above a line joining the iliac crests is arbitrarily diagnosed redundant colon. Of course this criterion includes many mild and asymptomatic cases. The amount of enema fluid necessary to fill to the cecum averages 46 ounces (about 1,380 c.c.) in redundant colons and has reached as high as 120 ounces (about 3,600 c.c.). These figures are to be contrasted with the average 38 ounces (about 1,140 c.c.), required to fill the normal colon completely.

In many cases the stomach is displaced and deformed. The usual displacement is to the right and, since the cardiac end is fixed, the resulting appearance has been

Incidence—In 1,850 roentgenographed patients, 343 cases of redundant colon were encountered, an incidence of 18.5 per cent. Analysis of this relatively large group shows that the anomaly affects both sexes (55 per cent females) and both extremes of habitus (29 per cent sthenics vs. 24 per cent asthenics) with approximately equal frequency. It is interesting to note, however, that the subvariety described as "pelvic loop to the right" occurs predominantly in the sthenic habitus. Thus in 48 cases of this group there were 56 per cent sthenics, 44 per cent intermediates, and no asthenics.

Clinical Picture (Table II)—In the ten years since the publication of our first study in 1924, numerous observers (Larimore, White, Moller, Gauss, Bush, Strauss, Dagnino, Piccinino, and particularly Chiray, Lomon, and Wahl) have agreed that the redundant colon probably represents a definite entity with a constant incidence and clinical picture. Although, as with all anomalies, symptoms may be absent or variable, the combination of constipation, pain, and gas distress is characteristic.

TABLE II — REDUNDANT COLON

	Incidence	Per cent
General in 1,850 roentgenographed patients		18
Sex		
Females		55
Males		45
Habitus		
Sthenics		29
Asthenics		24
Clinical Features		
Constipation (general incidence 46 per cent)		66
Distention, abdominal (general incidence 13 per cent)		21
Pain, abdominal (general incidence 47 per cent)		55
Pain, right lower quadrant (general incidence 9 per cent)		12
Tenderness right lower quadrant (general incidence 19 per cent)		27
Appendicitis, operation (general incidence 17 per cent)		22
Appendicitis 'pus' (incidence in appendicitis operation 16 per cent)		15

The constipation, which is present in 66 per cent of cases (general incidence, 46 per cent), usually dates from birth. It is characterized by long intervals between stools (often one week) and by difficulty in expelling enemas, but is on the whole not associated with marked systemic or general upsets. Gas distress is often striking. It is most characteristic in the form of abdominal distention and occurred in 21 per cent of cases as against a general incidence of 13 per cent in our unselected material. There is often localized distention corresponding to the redundant loop. Belching may represent a misdirected effort to relieve pressure in the splenic flexure, but this symptom occurred in only 21 per cent as against a general incidence of 34 per cent. The incidence of flatulence was the same as that in the unselected series (38 per cent).

Pain is present somewhere in the abdomen in 55 per cent of the cases (general incidence, 47 per cent). It is always due to superimposed spasm proximal to the point of redundancy and may be associated with localized colitis, especially in patients who have acquired the cathartic or enema habit. The pains may suggest carcinoma or diverticulitis of the colon, heart disease, gall-bladder disease, or appendicitis. Pain in the right lower quadrant was present in 11 per cent (general incidence, 9 per cent), and tenderness in the right lower

quadrant occurred in 27 per cent (general incidence, 19 per cent). Appendectomy was performed in 22 per cent as compared to a general incidence of 17 per cent in our basic 3,000 cases. Pus cases were, if anything, less frequent than in the general series.

Volvulus, although not encountered in this series, can occur only when the mesentery is elongated, as in redundant colon. It is our opinion, confirmed by the actual observations of several surgeons, that this accident usually follows violent efforts at purgation, resulting in irregular and atypical peristalsis.

Treatment—The management of redundant colon consists essentially in the withdrawal of all forms of colonic abuse and the restoration of normal function by conservative procedures. The details of this therapy have been published elsewhere. The prognosis for relief is good. Surgical intervention should be reserved for cases of volvulus only.

ANOMALIES OF ROTATION NON-ROTATION

Description and Roentgen Appearance—Non-rotation of the colon represents an arrest of development whereby the cecum and succeeding portions of the colon remain in the left half of the abdomen and the coils of the jejunum-ileum in the right portion of this cavity. The condition may be complete or incomplete. When complete non-rotation exists, a mesenterium commune is invariably present.

Roentgenologically the cecum is found in the pelvis either in the mid-line or actually to the left. The ceco-colon ascends in the mid-line, the transverse colon is short, bent into an irregular shape, or may even be indistinguishable, the splenic flexure, and the colon distal to it, occupy the usual position. The entrance of the ileum into the ceco-colon is from the right instead of from the left side (Fig. 5).

Although this condition is generally assumed to remain fixed in adult life, this is not always true. In one of our cases which was carefully studied (both after opaque meal and opaque enema) the cecum and ceco-colon were found to be on the right

side at the 24-hour observation of the progress meal, although a complete non-rotation was present at observations made 4, 6, 8, 9, 10, 11, 48, and 72 hours after

roentgenographed patients in whom the position of the cecum was carefully recorded—an incidence of 0.19 per cent. Two of our subjects were men, and two

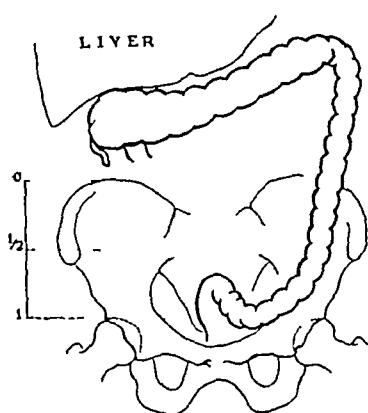


Fig 7 High cecum Sub-hepatic position (rare)

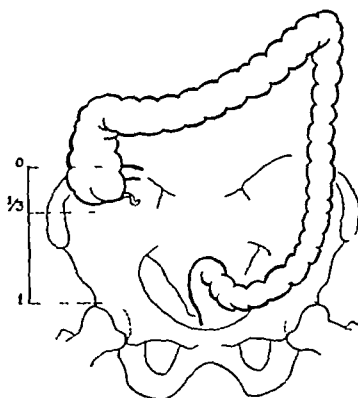


Fig 8 High cecum Common variety, showing roentgen landmarks

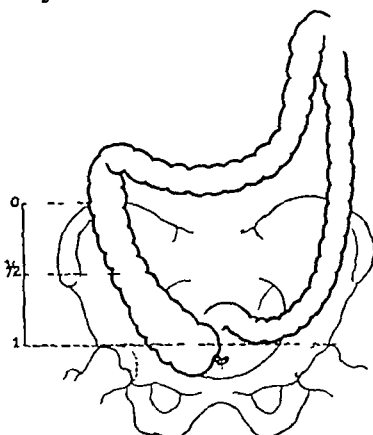


Fig 9 Low cecum Showing roentgen landmarks

the opaque meal. The usual opaque enema revealed a complete non-rotation. Following the evacuation of the barium, a contrast enema (airgram) was made, a procedure which caused a complete rotation of the colon to the normal position. A second opaque enema was then administered and the normal condition was again demonstrated. However, subsequent examinations showed that the colon had reverted to its non-rotated arrangement.

In all of our subjects the entire small intestine was also non-rotated, the duodenum never crossing the mid-line. The converse situation, however, is not invariably true, since non-rotation of the duodenum may exist without non-rotation of the colon. There are two such cases in the present series. Incomplete non-rotation (partial rotation) of the cecum has been described. Such forms have not been positively demonstrated in our material.

The amount of opaque enema required to fill the colon averaged 35 ounces (about 1,050 c c). In other words, it was just short of the normal figure of 38 ounces (about 1,140 c c).

Incidence—The condition is rare. Only four cases were encountered in 2,071

were women. In three, the habitus was described as intermediate, in the fourth it was asthenic.

Clinical Picture—In a series so small as the present it is impossible to draw any general conclusions regarding the clinical significance of non-rotation of the colon. However, because of the relative rarity of the condition a brief tabulation of findings may be worth recording. All four were constipated, nausea occurred in three subjects, vomiting in two, three of the patients complained of headache, vertigo was recorded in two cases, no notation of this symptom was made in the other two, abdominal pain was noted in two subjects, but one of these was suffering from duodenal ulcer. Grave (surgical) accidents resulting from non-rotation seem to be rare, no instance was recorded in this series. However, such a possibility must be borne in mind whenever a mesenterium commune is present.

ANOMALIES OF DESCENT HYPODESCENT (THE HIGH CECUM)

Description and Roentgen Appearance—The cecum may be arrested in its embryologic descent at any stage between the liver and its normal resting place, which

is the middle of the right iliac fossa (Fig 6) Since subhepatic ceca are rare (Fig 7)—we encountered but 27 cases in which the cecum was at or above the iliac crest—we have included all ceca occupying the upper part of the iliac fossa in a group which we have arbitrarily designated "high cecum" (Fig 8) The exact roentgen criteria delimiting this group are as follows

1 In its highest position in any film of a given case, studied routinely by opaque meal and opaque enema, the tip of the cecum must appear above the iliac crest, at the crest, or in the upper third of the iliac fossa—as measured between the crest of the ilium and top of the acetabulum on the film taken in the usual prone position during slight inspiration

2 In its lowest position in any film of the same given case, the tip of the cecum must lie within the upper half of the iliac fossa as above determined A cecum that extended half-way down or more was excluded from the series

3 The length of the ceco-colon as measured after the barium meal must not exceed 7 inches (17.5 cm) This figure was chosen as the maximum for high ceca because (as shown in a previous study of this series) it represents the average length of the ceco-colon in normally placed ceca These measurements are all obtained from films taken prone at a distance of 26 or 26.5 inches (65 or 66.3 cm) from the tube target

The diagnosis of high cecum is best made roentgenologically nine hours after the ingestion of an opaque meal In some cases the cecum is attached to the liver, but the proximal transverse colon hangs down, festoon-like, in such fashion as to resemble a normal ascending segment This may cause confusion unless observations are made in the right oblique position Usually the right iliac fossa is occupied by loops of terminal ileum, but in some 5 per cent of cases the latter are replaced by a loop of pelvic colon This arrangement has already been described as a subvariety of the redundant colon under

the descriptive title "pelvic loop to the right" Its recognition is of some clinical importance because it may still further confuse surgeons in their attempt to locate the ectopic appendix in emergency operations in cases presenting high cecum

Incidence—In our series of 2,071 roentgenographed cases, high ceca were observed in 134 (6.5 per cent) Males predominated strikingly over females (76 per cent vs 24 per cent), as did sthenics (74 per cent) over asthenics (4 per cent) High ceca are associated with hypofixation of the proximal colon (see below)

Clinical Picture (Table III)—On the whole, this group is composed of robust individuals remarkably free from the common manifestations of functional digestive upset In this respect they offer a striking contrast to the group of patients with low cecum, next to be described Using headaches and vomiting as typical expressions of functional digestive disorders, we find that the incidence of these complaints (18 per cent and 20 per cent, respectively) is about that in normal ceca (*i.e.*, in the general series) but is decidedly less than in low ceca

TABLE III—HIGH CECUM

	Incidence	Per cent
General, in 2,071 roentgenographed patients		6
Sex		
Males		76
Females		24
Habitus		
Sthenics		74
Asthenics		4
	Clinical Features	
Headaches (general incidence 23 per cent)		18
Vomiting (general incidence 20 per cent)		20
Constipation (general incidence 46 per cent)		36
Appendicitis, operation (general incidence 17 per cent)		23
Appendicitis "pus" (incidence in appendicitis operation 16 per cent)		26

Recalling the high incidence of constipation in redundant (long) colon, *viz.*, 66 per cent, it is interesting to observe that constipation occurs in but 36 per cent of cases of high cecum Since this figure is also appreciably lower than the general incidence of constipation in non-selected cases, it would appear safe to make the generalization that constipation varies directly as colonic length

The relation of high cecum to appendicitis is interesting. In the first place, the appendix being located at or near the liver instead of in the right iliac fossa, the

tops of both acetabular cavities on the standard prone film (Fig 9). In accordance with our concept that the low cecum represents a true overgrowth rather than a

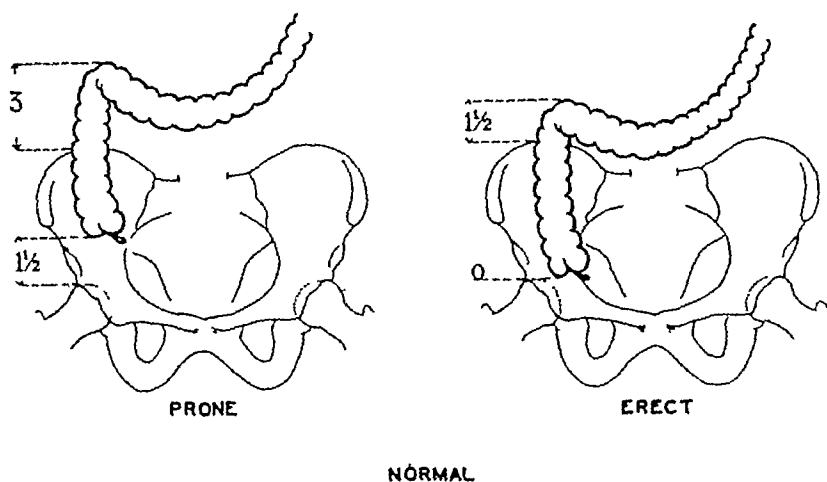


Fig 10 Normal fixation of proximal colon Showing range of mobility in prone and erect postures

clinical picture may resemble acute cholecystitis more than appendicitis. Furthermore, the presence of actual inflammation (pus appendix) is one and one-half times as likely (26 per cent) in high cecum as in the average appendectomy case (16 per cent), and more than two and one-half times more likely than in low cecum (10 per cent).

Treatment—High cecum, as such, requires no treatment. One should take no chances with symptoms suggesting appendicitis and must be prepared to find the appendix high in the abdomen.

HYPERDESCENT (THE LOW CECUM)

Description and Roentgen Appearance—The low cecum is the result of embryologic hyperdescent, the organ prolapsing below the right iliac fossa into the true pelvis. The anomaly furnishes a complete and striking contrast to the high cecum just described.

The diagnosis of low cecum is best made nine hours after the ingestion of the standard opaque meal. This anomaly may be said to exist when the cecal tip reaches down to or below the mid-pelvis, as determined by a horizontal line connecting the

local expression of ptosis, the length of the cecum in these cases is increased from the average 7 inches (17.8 cm) in the normal cecum, to an average of 9 inches (22.9 cm), with the maximum reaching 13 inches (32.5 cm). The cecal tip was fixed in 30 per cent of the cases, the rest of the cases showed a mobility of more than 1 inch (2.5 cm). These figures are based on a review of all films (barium meal and enema) of a given case. If only the 9-hour prone and erect observations are considered, the incidence of fixation is higher (see below).

The most common associated anomaly was represented by duodenal bands, which occurred in 13 per cent of cases, *i.e.*, over twice the general incidence.

Incidence—The low cecum ranks with redundant colon as one of the two most common anomalies of the colon. It was observed 379 times in our series of 2,071 roentgenographed patients, an incidence of 18.3 per cent. Women make up 74 per cent of the patients, and asthenics predominate over sthenics in the proportion of four to one (48 to 12 per cent). Low ceca are associated with hyperfixation of the proximal colon (see below).

TABLE IV—LOW CECUM

	Incidence	Per cent
General, in 2,071 roentgenographed patients		18
Sex		
Females		74
Males		26
Habitus		
Asthenics		48
Sthenics		12
Associated duodenal bands (general incidence 5 per cent)		13
Clinical Features		
Vomiting (general incidence 20 per cent)		41
Headaches (general incidence 23 per cent)		40
Pain, right lower quadrant (general incidence 9 per cent)		13
Tenderness, right lower quadrant (general incidence 19 per cent)		24
Appendicitis, operation (general incidence 17 per cent)		26
Appendicitis, "pus" (incidence in appendicitis operation 16 per cent)		10

Clinical Picture (Table IV)—Low cecum is, we believe, responsible for a definite symptomatology. The complaints are of two orders, namely, general and local. The general symptoms are those ordinarily regarded as reflex or toxic in character. Chief among these are vomiting, which occurred in 41 per cent (general incidence, 20 per cent), and headache, which occurred in 40 per cent (general incidence, 23 per cent).

The vomiting in these cases is habitual and rather easy, being provoked by strain, fatigue, emotional excitement, dietary indiscretion, menstruation, and headaches. The patient may take this symptom so much for granted that she may fail to mention it in the history unless specifically questioned.

The headaches are often of the migraine type and are caused by the same factors as is the vomiting. Both these major manifestations may be represented by less severe symptoms. Thus, vomiting may be replaced by nausea, train or car sickness, and headaches by vertigo. These patients often exhibit other stigmas of physical, nervous, or emotional instability.

The local symptoms are referable to the right lower quadrant. Spontaneous pain in this region, which occurs in 9 per cent of all patients, is observed in 13 per cent of cases of low cecum. Tenderness in the right lower quadrant is also present more

often (24 per cent) than in the general series (19 per cent). When cecal stasis is associated with low cecum, the figures for right-sided pain and tenderness increase from 13 and 24 per cent to 21 and 28 per cent, respectively. It is undoubtedly for this reason that patients with low cecum constitute the most frequently appendectomized group of colon anomalies (26 per cent *vs* 17 per cent, general incidence). Appendix removal is obviously unwarranted in most cases because of the following reasons: (1) There is nothing in the history of low cecum on which a diagnosis of appendicitis can be properly based, (2) the observations at operation show the smallest proportion of pus cases of any group of colon anomalies that we have studied, namely, 10 per cent as against a general incidence of 16 per cent and an incidence in high cecum of 26 per cent.

Explanation of Symptoms—In previous articles an explanation was offered for the symptoms encountered in cases of low cecum. As this explanation was largely theoretical, and particularly since it has not yet been confirmed or refuted by others, only the following summary will be presented here.

According to this hypothesis, the cause of the symptoms in low cecum may actually reside in the duodenum in which transient stasis is produced, no gross obstruction taking place. The transient retentions are assumed to result from the intermittent drag of the low cecum, the pressure being mediated through any of the structures that cross the second or third portion of the duodenum. These structures are the transverse mesocolon crossing the second portion, the right and middle colic artery, the superior mesenteric artery, and the root of the mesentery of the small intestine crossing the third portion. According to this view, the actual occurrence of symptoms would be favored by such features as the erect posture, stasis in the cecum, mesenterialization (hypofixation) of the ascending colon with increased mobility of the cecum, and the presence of duodenal bands. The latter adhesions would, by fixing the duodenum, tend to "step up"

the effect of colonic dragging so that sub-minimal stimuli might become effective

Treatment—The medical management of low cecum consists in treating the

Much has been written about the clinical (especially the surgical) significance of both hypofixation and hyperfixation without a sound knowledge of important basic

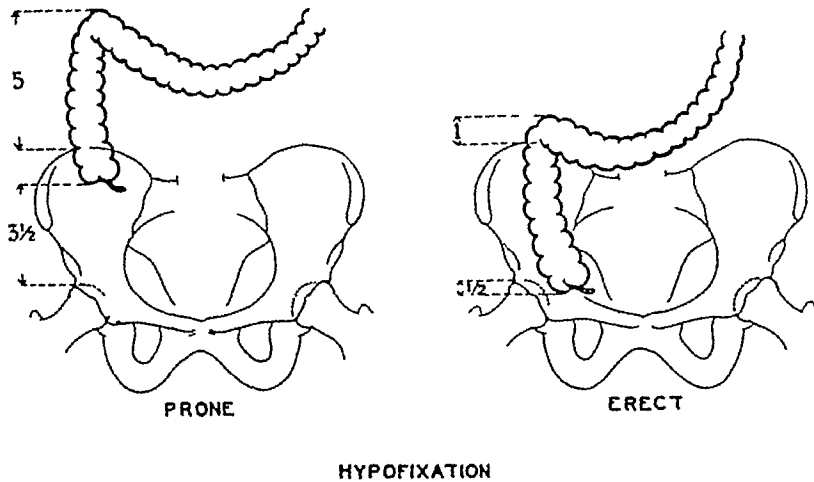


Fig 11 Hypofixation of proximal colon Showing range of mobility in prone and erect postures

asthenic habitus, controlling the neurosis, fattening the patient, and relieving the cecal stasis, which may be accomplished by correcting the distal constipation when present, thus clearing the track ahead. In none of our cases was it found necessary to recommend surgical therapy.

ANOMALIES OF FIXATION

Description and Roentgen Appearance—

The process of fixation of the large intestine is normally completed by the sixth or seventh month of fetal life. Departures from the normal development may take place in either of the following two directions. (1) There may be an arrest in fixation with a persistence of the primitive mesentery and increased mobility (hypermobility, hypofixation) of the ascending colon, with or without a mesenterium commune, or (2) there may be an abnormal progression of the fixation process, resulting in excessive adhesion (hyperfixation, hypomobility). This excess of fixation may involve the whole course of the ascending colon, or only certain portions of it. Similar abnormalities may affect the distal colon but they are more difficult to study and will not be considered in this communication.

data concerning colonic fixation. A study of this subject correlating essential clinical and roentgen data in 383 cases has recently been published by the writer. In that communication detailed statistics are presented relating to the fixation of the hepatic flexure alone, the cecum alone, and the ceco-colon as a whole. The following paragraphs represent a summary of this investigation.

Roentgen Technic and Criteria—Fixation of the ascending colon is best studied nine hours after the administration of an opaque meal. Films are made in both erect and prone positions (Fig 10). The location of the hepatic flexure is noted in relation to the crest of the right ilium in each position. Similarly, the location of the tip of the cecum is noted in relation to the top of the right acetabulum.

The average range of mobility of the hepatic flexure in the shift from the prone to the erect posture is one and two-thirds inches (4.2 cm). The average vertical mobility of the cecum is about one and one-third inches (3.4 cm). For the purpose of this study, excessive mobility of the hepatic flexure was arbitrarily diagnosed when the vertical excursion reached 3 inches (7.4 cm) or more. Ex-

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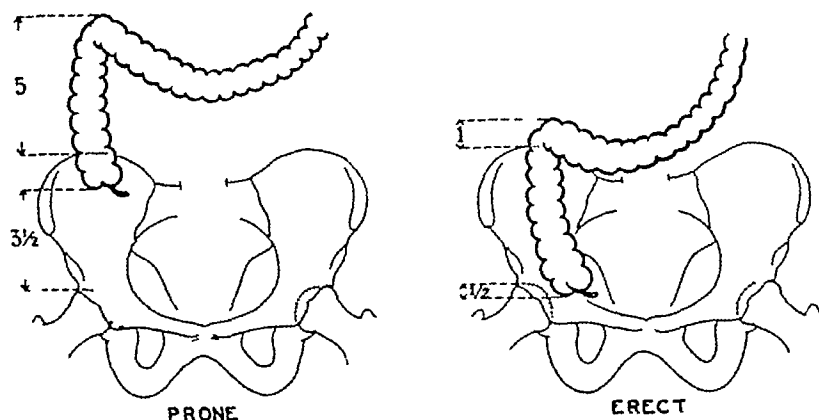
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HYPOFIXATION

Fig 11 Hypofixation of proximal colon Showing range of mobility in prone and erect postures

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cessive mobility of the cecum was diagnosed when the excursion reached two and one-half inches (6.4 cm) or more. Excessive fixation of either the hepatic

flexure or the cecum through a hernia. In Wandel's classic case of mesenterium commune, the duodenum and mesenteric pedicle were completely encircled and

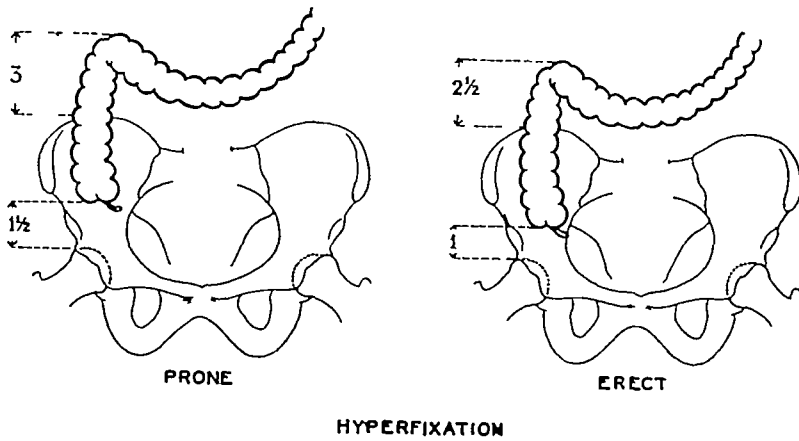


Fig 12 Hyperfixation of proximal colon. Showing range of mobility in prone and erect postures

flexure or the cecum was arbitrarily assumed to exist when the vertical range in mobility resulting from change in posture was 1 inch (2.5 cm) or less.

HYPOFIXATION (EXCESSIVE MOBILITY)

Incidence—Hypofixation of either the hepatic flexure or the cecum occurred in 10 per cent of the 383 cases studied in this series. Hypofixation of the ceco-colon as a whole occurred in 4 per cent of the cases. Excessive mobility in general is associated with the sthenic habitus and with a high cecum (Fig 11, Table V).

Clinical Picture—Hypermobility of the hepatic flexure alone is associated with right lower quadrant pain (25 per cent *vs* general incidence of 9 per cent) and with right lower quadrant tenderness (27 per cent *vs* general incidence of 19 per cent). There is also an association, though less striking, with colonic stasis.

Hypermobility of the cecum alone is associated with increased colonic irritability. Hypermobility of the entire ceco-colon, with or without a mesenterium commune, is a prerequisite for such acute surgical complications as volvulus of the ceco-colon, ileo-cecal intussusception, and pro-

strangled by the absolutely unattached proximal colon. (As has already been mentioned, cases of non-rotation of the cecum are of necessity also cases of mesenterium commune.) Finally, it may be mentioned that none of our 19 mobile ceco-colon cases developed any of the acute surgical complications above mentioned.

HYPERFIXATION (EXCESSIVE FIXATION)

Incidence—Hyperfixation of the hepatic flexure occurred in 28 per cent of the cases, of the cecum in 43 per cent of the cases, and of the ceco-colon in 20 per cent of the cases. As already mentioned under "low cecum," if all the films of a given case are considered, the figures for the cecum (and perhaps for the rest of the ceco-colon in proportion) will be found to drop to 30 per cent. Excessive fixation, in general, is associated with low ceca and with duodenal bands (Fig 12, Table VI).

Clinical Picture—Hyperfixation of the hepatic flexure alone is associated with a moderate tendency to colonic irritability. Contrary to the common opinion, there is no evidence of association with gall-bladder disease, nor does cholecystectomy

tend to fix the hepatic flexure. In other words, in the majority of instances the fixation represents a congenital, not an acquired, phenomenon.

Hyperfixation of the cecum alone, when the organ is not low placed, is apparently asymptomatic. There is no evidence that cecal fixation results from appendectomy. Hyperfixation of the entire ceco-colon is associated with increased colonic irritability.

Therapy—Variations in fixation of the ceco-colon as a whole, or of either of its terminations (cecum, hepatic flexure) do not seem to be responsible for any marked clinical disturbances. The symptoms encountered resemble those commonly associated with the unstable colon and respond reasonably well to conservative medical management. In none of the cases

reported in this study was it found necessary to recommend surgical therapy. This should be restricted to cases in which intestinal obstruction is demonstrated.

SUMMARY

This study is based on a series of approximately 2,000 consecutive cases in which the colon form and function was observed roentgenologically. This series, in turn, constitutes a part of a basic group of approximately 4,000 private patients complaining of various digestive symptoms, thus furnishing a homogeneous background for the conclusions here presented.

Anomalies of the colon are discussed under the following headings:

Anomalies of length: Redundant colon.

Anomalies of rotation: Non-rotation.

TABLE V—HYPOFIXATION OF PROXIMAL COLON

	Hepatic Flexure (40 cases)	Cecum (40 cases)	Ceco-colon (15 cases)	General Incidence
Incidence (Per cent)				
General in 383 roentgenographed patients	10	10	4	
Habitus				
Asthenic	10	8	7	21
Sthenic	47	55	60	29
Associated Anomalies				
High Cecum	15	30	27	6
Low Cecum	13	3	0	18
Duodenal Bands	8	8	13	5
Clinical Features (Per cent)				
Right Lower Quadrant Pain	25	10	20	9
Right Lower Quadrant Tenderness	28	18	13	19
Constipation	58	33	47	47
Colitis ' (Irritable Colon)	58	73	73	57
Gall bladder Disease	13	13	20	6

TABLE VI—HYPERFIXATION OF PROXIMAL COLON

	Hepatic Flexure (107 cases)	Cecum (166 cases)	Ceco-colon (76 cases)	General Incidence
Incidence (Per cent)				
General in 383 roentgenographed patients	28	43	20	
Habitus				
Asthenic	19	31	24	21
Sthenic	32	28	29	29
Associated Anomalies				
High Cecum	3	4	5	6
Low Cecum	26	39	37	18
Duodenal Bands	10	11	11	5
Clinical Features (Per cent)				
Right Lower Quadrant Pain	8	13	15	9
Right Lower Quadrant Tenderness	16	22	18	19
Constipation	45	46	42	47
Colitis ' (Irritable Colon)	67	56	64	57
Gall bladder Disease	3	5	4	6

cessive mobility of the cecum was diagnosed when the excursion reached two and one-half inches (6.4 cm) or more. Excessive fixation of either the hepatic

lapse of the cecum through a hernia. In Wandel's classic case of mesenterium commune, the duodenum and mesenteric pedicle were completely encircled and

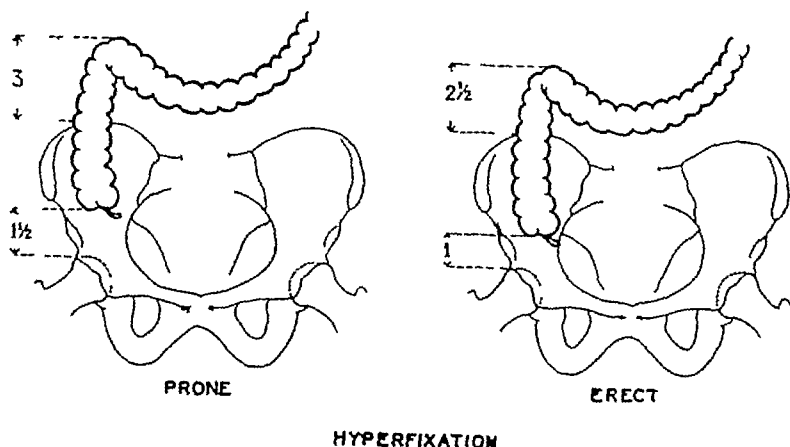


Fig 12 Hyperfixation of proximal colon. Showing range of mobility in prone and erect postures.

flexure or the cecum was arbitrarily assumed to exist when the vertical range in mobility resulting from change in posture was 1 inch (2.5 cm) or less.

HYPOFIXATION (EXCESSIVE MOBILITY)

Incidence—Hypofixation of either the hepatic flexure or the cecum occurred in 10 per cent of the 383 cases studied in this series. Hypofixation of the ceco-colon as a whole occurred in 4 per cent of the cases. Excessive mobility in general is associated with the sthenic habitus and with a high cecum (Fig 11, Table V).

Clinical Picture—Hypermobility of the hepatic flexure alone is associated with right lower quadrant pain (25 per cent *vs* general incidence of 9 per cent) and with right lower quadrant tenderness (27 per cent *vs* general incidence of 19 per cent). There is also an association, though less striking, with colonic stasis.

Hypermobility of the cecum alone is associated with increased colonic irritability. Hypermobility of the entire ceco-colon, with or without a mesenterium commune, is a prerequisite for such acute surgical complications as volvulus of the ceco-colon, ileo-cecal intussusception, and pro-

strangled by the absolutely unattached proximal colon. (As has already been mentioned, cases of non-rotation of the cecum are of necessity also cases of mesenterium commune.) Finally, it may be mentioned that none of our 19 mobile ceco-colon cases developed any of the acute surgical complications above mentioned.

HYPERFIXATION (EXCESSIVE FIXATION)

Incidence—Hyperfixation of the hepatic flexure occurred in 28 per cent of the cases, of the cecum in 43 per cent of the cases, and of the ceco-colon in 20 per cent of the cases. As already mentioned under "low cecum," if all the films of a given case are considered, the figures for the cecum (and perhaps for the rest of the ceco-colon in proportion) will be found to drop to 30 per cent. Excessive fixation, in general, is associated with low ceca and with duodenal bands (Fig 12, Table VI).

Clinical Picture—Hyperfixation of the hepatic flexure alone is associated with a moderate tendency to colonic irritability. Contrary to the common opinion, there is no evidence of association with gall-bladder disease, nor does cholecystectomy

SOURCES OF ERROR IN ORAL CHOLECYSTOGRAPHY, WITH SUGGESTED METHODS OF CORRECTION¹

By WILLIAM H STEWART, M D , and H EARL ILLICK, M D , New York City

From the Roentgenological Department, Lenox Hill Hospital

A SATISFACTORY oral Graham series requires more attention to detail than any other type of x-ray examination. To overlook any one of many essentials in performing the test may ruin the entire examination. While certain standardization is helpful, there must be variation in technic if the full value of the method is utilized.

There are certain errors in cholecystography which are due, *first*, to the patient, *second*, to the technic, and—last and most important—due to misinterpretation. These will be dealt with in their order and an effort made to outline corrections.

First, Errors Due to the Patient—An individual may be unable to co-operate fully on account of illness, or he may misunderstand the instructions so that he does not do as directed.

Completely suspending respiration is very difficult for some patients, especially should they be suffering from cardiac lesions or ascites. Much can be gained by taking sufficient time properly to instruct the patient before any films are exposed. It is surprising to note how many individuals are unable to comprehend simple instructions and fail repeatedly in carrying them out. Holding the nose during suspension of respiration is often of great assistance. Comparison of a number of films of the same patient made at the same time will always show some of greater brilliance of detail than others and these films invariably are those made while the patient suspended respiration most satisfactorily.

There may be inadequate preparation of the patient because of "gas" pockets in the hepatic flexure or stomach or even retained intestinal contents. Incompletely absorbed

dye may also interfere with clear visualization of the gall-bladder region. It is essential that a *cleansing enema* be given immediately before the examination in cases in which the gall bladder is to be outlined with maximum intensity so that the bowel may be clear of confusing, overlying shadows.

The patient may have been given something to eat during the fasting period due to a misunderstanding of orders and the gall bladder may be partially emptied of its opaque bile as a result of this lack of co-operation.

Second, Errors Due to Imperfect Technic—Many errors may creep into the technic of performance of the oral Graham test. Let us consider those concerning the tetraiodo first.

It is essential that the dye be stored in amber glass ampoules or air-tight containers so that no oxidation or other chemical changes may occur before the patient receives it. The authors have found that the most satisfactory method of administering the dye is to dissolve it in a glass of water seasoned with a little fruit syrup.

TECHNIC OF THE INTENSIFIED METHOD

Using oral cholecystography as a means for investigating the emptying power of the gall bladder following the administration of cholegogues, we noted that in cases in which starvation was continued and the dye repeated the gall-bladder shadow was markedly intensified (1). We supplemented these findings with certain research developments of Antonucci (2) and Sandstrom (3), the former having demonstrated that oral cholecystography may be accelerated by adding to the glucose reserve of the body, and the latter having found that

¹ Read before the Fourth International Congress of Radiology at Zurich, Switzerland, July, 1934.

Anomalies of descent Hypodescent, hyperdescent

Anomalies of fixation Hypofixation, hyperfixation

The redundant colon (*dolichocolon*) was present in 18 per cent of cases. Its chief clinical aspects are its occurrence in all builds and both sexes, and its association with marked constipation, and, less often, with pain and gas.

Non-rotation of the colon is rare. It was present in about 0.2 per cent of cases. It is often a manifestation of non-rotation of the entire intestinal tract in which case it is associated with mesenterium commune. In the majority of cases the condition seems to be asymptomatic.

High cecum (hypodescent of the cecum) occurred in 6 per cent of cases. Its chief clinical aspects are its occurrence in eupeptic, sthenic males, and the ectopic position and increased tendency to inflammation of the appendix.

Low cecum (hyperdescent of the cecum) occurred in 18 per cent of cases. Its chief clinical aspects are its occurrence in asthenic women and its association with headaches and vomiting, and discomfort in the right lower quadrant.

Hypofixation (excessive mobility) of the proximal (ceco-) colon occurred in 4 per cent of cases. It is associated with the sthenic habitus and high cecum, and is a prerequisite for volvulus and intussusception. Hypofixation of the hepatic flexure alone is associated with right lower quadrant pain and tenderness. Hypofixation of the cecum alone is associated with increased colonic irritability.

Hyperfixation (excessive fixation) of the proximal (ceco-) colon occurred in 20 per

cent of cases. It is associated with low ceca, duodenal bands, and colonic irritability. Hyperfixation of the hepatic flexure alone is associated with colonic irritability. Hyperfixation of the cecum alone is apparently asymptomatic.

Surgical therapy is not indicated in the great majority of colon anomalies. This form of treatment should be reserved for instances of actual intestinal obstruction. In most cases a conservative plan of management, based on the restoration of normal colon function, suffices for the relief of symptoms.

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Fig 3 Case B Sixteen hours after tetraiodo, film taken by old technic.



Fig 4 Case B Note increase in density in normally functioning gall bladder, with "intensified technic"

of cholesterol stones are visualized more readily (Fig 10)

The bile ducts are clearly outlined in practically every case in which a normal gall-bladder shadow intensity is obtained

A gall bladder over the spine, which was formerly easy to miss and report as a "no shadow," is now more easily detected

Fluoroscopy of the gall bladder is practical on any case in which a gall-bladder shadow is obtained

There are certain *roentgenographic improvements* which aid in obtaining these better roentgenograms

A fast Bucky is now used which permits exposures up to one-twentieth of a second. With such fast technic, fuzziness of the gall-bladder shadow due to motion is lessened, if not entirely overcome. The contrast obtainable is extreme and the visualization of small calculi is rendered more exact

Compression is an advantage when the patient will permit it. It is amazing how much difference in the quality of roentgenograms results when the patient is thoroughly compressed and the abdominal organs are immobilized

We use a standard technic of 100 ma and one-half second time, with less time in

certain cases. A fine focus tube may be used at this milliamperage and the general quality of the work is excellent. The results obtained from a Graham test satisfactorily performed may be grouped in five main classes

- (A) The gall bladder is visualized
- (B) The gall bladder is faintly visualized
- (C) The gall bladder fails properly to empty
- (D) There is no distinguishable gall-bladder shadow
- (E) Gallstones are present

With any of these findings, one may make certain mistakes of interpretation

(A) When a gall-bladder shadow is outlined with fair intensity, the inclination of the interpreter is to regard the viscus as normal in function and, therefore, not diseased. Such a statement may be incorrect, as patients recovering from a recent attack of acute cholecystitis have been repeatedly examined and an excellent shadow obtained. The organ recovers from an acute disease and the mucosal function is regained sufficiently to result in normal shadow concentration

Adhesions may result following an acute

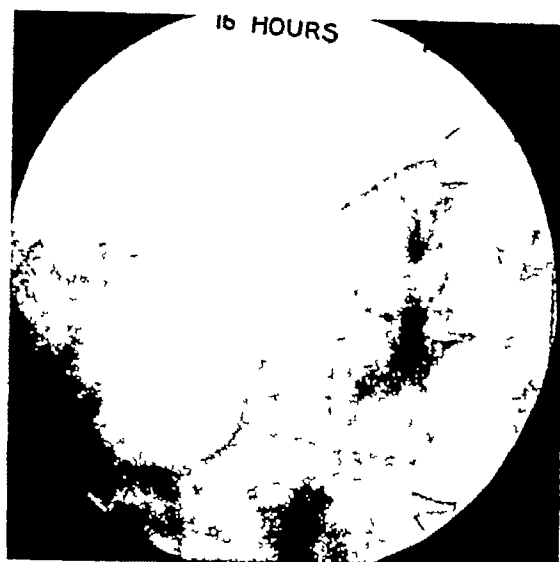


Fig 1 Case A Oral cholecystography Film taken 16 hours after tetraiodo A faint shadow (by old technic)

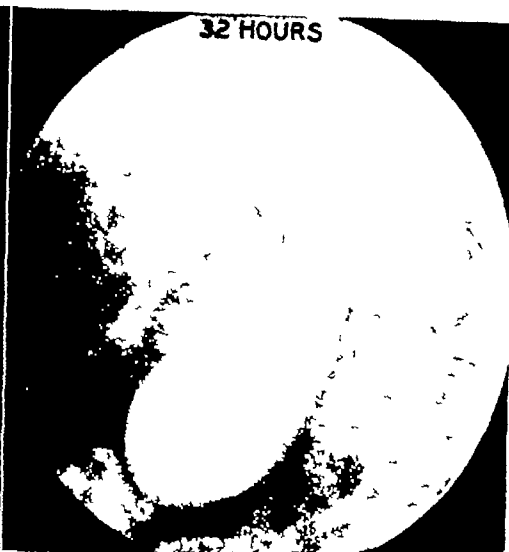


Fig 2 Case A Forty hours after intensified technic The advantages of the new method can be readily appreciated This is no longer a "faint shadow" case

giving the dye in fractional doses increased the shadow. The authors have devised the following new technic for what they claim is the "intensified method of oral cholecystography, the details of which follow."

The afternoon preceding the Graham test the patient is given two or three cups of weak tea with as much sugar as possible, accompanied by one sweet cake.

The tetraiodo (3.5 grams) is given directly after the evening meal, at about 7 P.M. No extra fats are ordered at this meal as they generally cause increased discomfort and are not necessary.

Starvation is ordered for the following morning and its importance explained to the patient. Study of the gall bladder is undertaken sixteen hours after administration of the dye, to estimate the mucosal function of concentration. With the new intensified technic there has been a tendency to drop the 12-hour examination as unnecessary or needless. Selected foods are then allowed which will not empty the gall bladder, *extra sugar* being one of the important items. Additional dye is given in small doses during the afternoon and evening, along with more sugar. An examination of the gall bladder for maximum

concentration and intensity of the shadow is then made before breakfast the following morning, forty hours after the first dose of tetraiodo. Then a fatty meal is taken and an hour later study is made of the function of contractability as the viscus empties. Tumors and stones often come to light as the gall bladder empties. Sometimes the patient has to be kept under observation for a number of hours as emptying progresses.

This modified technic has certain definite advantages to compensate for the additional time and limited intake—to which most gall-bladder patients do not object to anyway. There is *less* nausea and discomfort complained of by the patient with this new method.

There is far more uniformity to the normal intense shadow obtained at the 40 hour observation, whereas many normal cases varied considerably in the shadow density at the 16-hour with the old technic.

It is far easier to determine when a shadow is *faint*. The intensified method either gives a shadow or not, and the *faint shadow is more rare* than with the former technic (Figs 1 and 2).

Stones and tumors of the gall bladder are more easily recognized *faint shadows*.



Fig 3 Case B Sixteen hours after tetraiodo film taken by old technic.



Fig 4 Case B Note increase in density in normally functioning gall bladder, with 'intensified technic'

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Adhesions may result following an acute



Fig 5 Case C Film taken 40 hours after first dose of tetraiodo, intensified technic. Note that the beautiful gall bladder outline is as dense as the barium filled stomach. Good function.

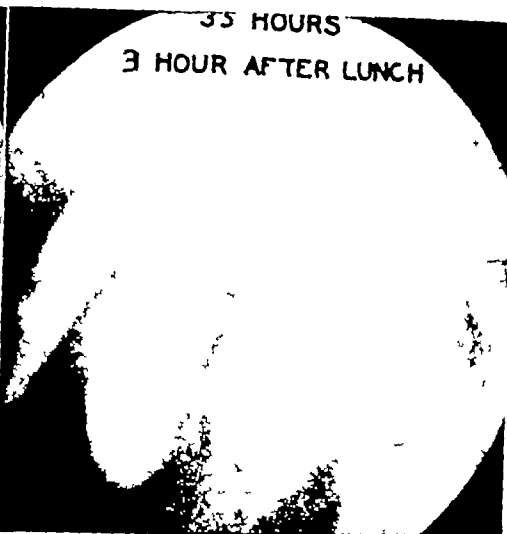


Fig 6 Case C New technic, film taken three hours after lunch. Note slow emptying, with detail of ducts.

attack of cholecystitis, so that the viscus may be literally coated or sheathed in them. The Graham test may demonstrate a normal gall-bladder shadow of good intensity and not deformed. The fact that the viscus is held constantly in an unusual position, whether the patient is erect, supine, or prone, usually indicates adhesions, and fluoroscopy may aid in detecting lessened mobility and tenderness. Further study of the gall bladder as it contracts down after an emptying meal may aid. In some cases we have resorted to pneumoperitoneum to actually demonstrate the adhesional bands.

The long pendulous gall bladder may appear deformed on some films or even maintain a fixed abnormality which disappears when the patient is examined in the erect position (Figs 7 and 8).

If the gall bladder functions normally so that a shadow is obtained of average intensity and the viscus contracts down well after a meal, any adhesions which are present are scars of previous disease and not necessarily causing the present complaints. We have heard one surgeon volunteer the statement that he has stopped operating on gall bladders with visible shadows on a Graham test because he has

found by experience that, when he does, the patients return later on with no improvement of symptoms.

(B) *Faint Shadow*—It is in the recognition of this condition that the roentgenographic diagnosis of cholecystitis is most often overlooked.

The authors have frequently been asked, "Just what do you consider a faint shadow?" We have to confess that there is a certain human element involved that cannot be described with unfailing exactitude. One man may consider a shadow faint while another is satisfied that it is within normal limits.

All this applies to the old technic. With the intensified method of cholecystography, one can be much more definite and immediately recognize a shadow that is faint. It is learned by experience, however, and not by any shadow index. The pathology that gives a faint shadow finding is most often located in the mucosa, producing a lack of proper concentration.

(C) *Defective Emptying*—We believe, as many observers before us have reported, that when the gall bladder fails to completely empty within three hours after a fatty meal, it is pathologic and that this lack of proper emptying is due to a lesion

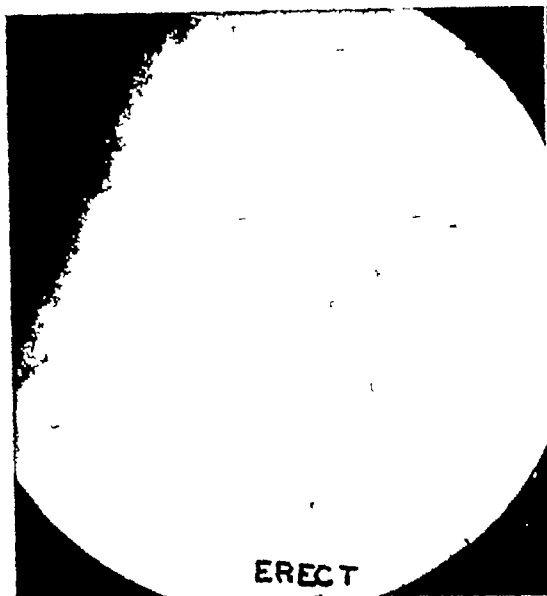


Fig 7 Case D Note elongated gall bladder in erect position with intensified technic



Fig 8 Case D Note deformity of gall bladder produced by position No adhesions

involving the muscular coat In our experience there is only one non-pathologic condition which will produce delayed emptying and that is asthenia These cases are rare, but occasionally individuals of this type will present themselves and their gall bladders will not completely empty for twenty-four hours and sometimes longer

(D) *No Shadow*—These findings are of increased importance when resulting at forty hours with this technic, and hardly need checking or further confirmation unless there is reason to suspect error that can be corrected

There is a high average of obstructed cystic ducts as a cause for this finding of "no shadow" and many times calcified stones are distinguishable as direct proof of this etiology The region of the lateral border of the spine should be carefully searched for the ring like shadow of a gallstone in the cystic duct in all "no shadow" cases

One should always be certain before making his report that the gall bladder has not been removed by previous operative procedure Also there should be a definite, authoritative statement as to the presence or absence of jaundice Inquiry

should be made as to whether the patient had diarrhea or vomiting following the dye and whether anything was eaten that should not have been All these conditions tend to prevent satisfactory results from cholecystography

The "no shadow" finding makes it necessary to be certain that the technic is not faulty Films of a Graham series without a perceptible shadow are the ones brought in most frequently from outside laboratories by anxious physicians who desire to know if the patient should be operated upon To judge such films, whether satisfactory or not, certain rules must be kept in mind

(1) Is there dye present in the intestines and visible on the films so that we know that the patient received the test and that it was not lost by vomiting or diarrhea?

(2) The lower edge of the liver shadow and the right kidney must be clearly outlined as well as that of the psoas muscle Status inversus must be excluded

(3) The bony trabeculae of the ribs and spine must be sharply outlined

(4) The examination must include the pelvis if the patient is thin If the re-

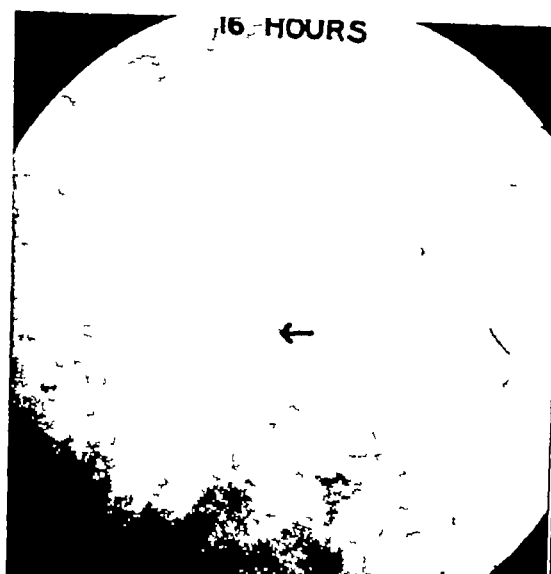


Fig 9 Case E Note faint gall bladder shadow with constriction large non-opaque stone in lower segment Old technic



Fig 10 Case E Intensified technic film taken 40 hours after first dose of tetraiodo Note increased detail to constricted gall bladder shadow with stone

verse, the lateral chest and abdominal wall should be included so that the gall bladder is within the area examined

(5) Study of the spine must be made to be certain that the gall bladder is not hidden by the bony structure

(6) At least three satisfactory films must be available covering each examination period

In cases of duodenal ulcer, a "no shadow" finding sometimes results. With this technic it is advisable to consider that two lesions are present, a duodenal ulcer and a diseased gall bladder. We have had numerous cases of duodenal ulcer with normal gall-bladder shadows.

Renal tumors, when extensive, may give a "no shadow" finding and the gall bladder be found apparently normal at operation.

Regardless of the cause of the jaundice, the oral Graham test fails to outline the gall bladder *satisfactorily* if the ichteric index is over 30. This corresponds to an ichterus which is barely tinting the skin in a good light. Just why the bile is not opaque in the presence of jaundice is difficult to understand. Investigations are now under way which attempt to supply

the deficiency in glycogen in the liver which is present in varying degrees in jaundice, by giving the patient increased quantities of sugar. In some cases we have been able to render the bile opaque, although the shadow obtained of the gall bladder was faint.

(E) *Gallstones*—Gallstones are of two types in their roentgenographic manifestations, calcified and non-calcified, or cholesterol, stones.

If there is sufficient calcium content, the calculi are discernible without the Graham test, this is true in about one-third of the cases. There is quite a large group of patients with gallstones of such low calcium content that they are invisible except on roentgenograms of the highest technical quality.

Non-calcified stones are preceptible only when a gall-bladder shadow is present. If the cystic duct is obstructed, the tetraiodo cannot enter the gall bladder and no shadow of the viscus will result. The gall bladder may be filled with cholesterol gallstones but they will be invisible as long as the gall bladder is not outlined with opaque bile. This is the confusing "no shadow" case without visualization of the

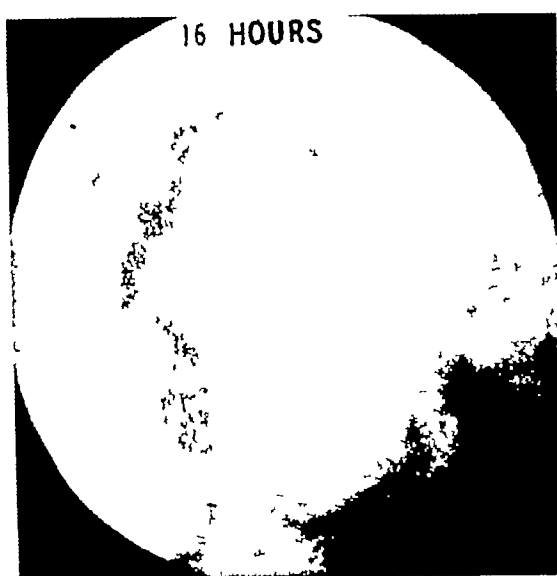


Fig 11 Case F Film taken at 16 hours old technic. A faint shadow with indefinite mottling from multiple small calculi

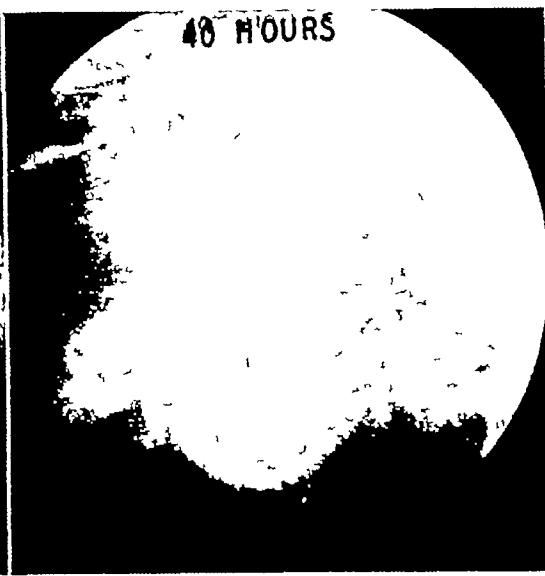


Fig 12 Case F Film taken at 40 hours intensified technic. The pathology is clearly demonstrated due to the increased detail

gall bladder or stones, the clinical findings may be indefinite as well. It is this type of case which requires flawless, exacting attention to every detail of the roentgenographic technic, or mistakes will surely be made.

Small *cholesterin stones* and sometimes a large solitary calculus may give a confusing shadow, barely perceptible even on films of excellent technical quality, and difficult to differentiate from gas bubbles and intestinal content. There are certain shadows from stomach and intestinal content which can be differentiated from gallstones only by repeated examinations or special maneuvers. A cleansing enema and an immediate re-examination, the drinking of half a glass of hot water, massage of the abdomen, or a short walk are measures which may solve the difficulty. Repeating the test is the final and most efficacious attempt toward success in the correct interpretation. A dozen pinhead-size cholesterol gallstones and even a single large stone or an adenoma or papilloma of the gall bladder may be overlooked unless the shadow intensity of the viscus is satisfactory. Unfortunately, the lesion may cause a faint shadow, with the result that the small stones are not detected. This is

another reason why the utmost shadow opacity of the gall bladder is desirable and why the *intensified technic* is more efficient. The study of the emptying of the gall bladder usually aids in defining the lesion.

Differentiation of extrinsic shadows likely to be mistaken for stones include the following:

Gas in the Duodenum—Bubbles of gas in the small intestines and pyloric region may directly overlie the gall bladder and cause confusing shadows easily mistaken for non-calcified stones. As a rule, shadows of gas bubbles shift in position on various films sufficiently so that their lack of the same shape, size, and constant position differentiate them. Taking a glass of hot water, several deep breaths, or a walk before another film may displace them. Gas bubbles have a sharper margin and the blackness of the gas is greater than non-calcified stones, whose borders are less sharply defined and whose central portion is gray rather than black. Non-calcified stones may be single or multiple, and, if multiple, the edge of the shadow may tend to be faceted. When multiple, the shadows of the stones are generally much the same size and uniform in appearance,

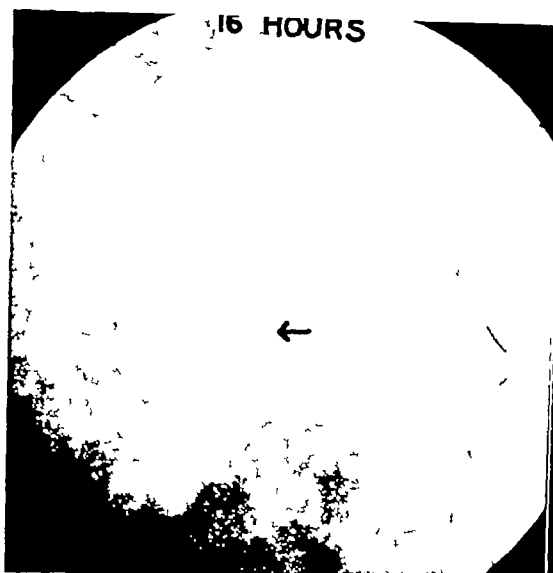


Fig 9 Case *E* Note faint gall-bladder shadow, with constriction large non-opaque stone in lower segment Old technic



Fig 10 Case *E* Intensified technic film taken 40 hours after first dose of tetraiodo Note increased detail to constricted gall-bladder shadow, with stone

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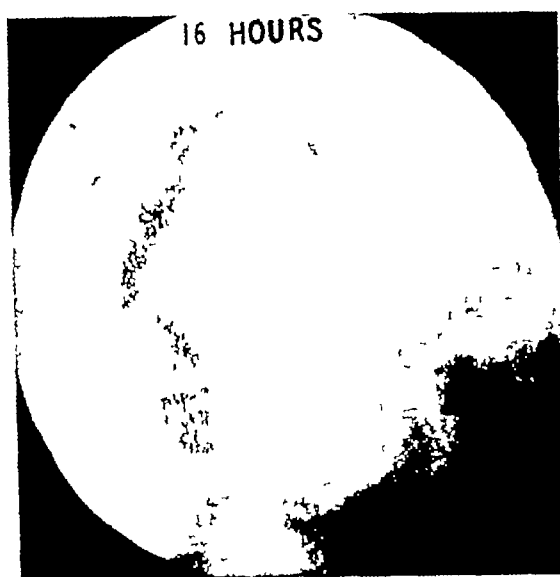


Fig 11 Case F Film taken at 16 hours old technic. A faint shadow with indefinite mottling from multiple small calculi

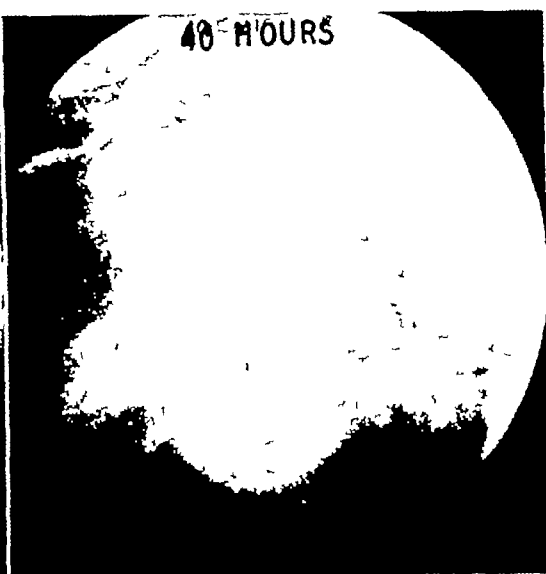


Fig 12 Case F Film taken at 40 hours intensified technic. The pathology is clearly demonstrated due to the increased detail

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Gas in the Duodenum—Bubbles of gas in the small intestines and pyloric region may directly overlie the gall bladder and cause confusing shadows easily mistaken for non-calcified stones. As a rule, shadows of gas bubbles shift in position on various films sufficiently so that their lack of the same shape, size, and constant position differentiate them. Taking a glass of hot water, several deep breaths, or a walk before another film may displace them. Gas bubbles have a sharper margin and the blackness of the gas is greater than non-calcified stones, whose borders are less sharply defined and whose central portion is gray rather than black. Non-calcified stones may be single or multiple, and, if multiple, the edge of the shadow may tend to be faceted. When multiple, the shadows of the stones are generally much the same size and uniform in appearance,



Fig 13 Case F Note gall bladder shadow in the presence of calcified gallstones Old technic, film taken 16 hours after tetraiodo



Fig 14 Case F Note concentration of gall bladder even in the presence of numerous stones cystic duct patent This film was taken 40 hours after first dose of tetraiodo New technic

whereas gas has bizarre shapes—no two alike. The film after the emptying meal forces the stones together and the general bunching of the stones within the gall-bladder shadow is quite characteristic. Study of the contracting gall bladder is prolonged in the intensified method and this is an added advantage of the new technic.

Calcified mesenteric glands have the following characteristics. The shadows are mottled like the mottled surface of a loganberry or raspberry, they may be a cluster of round dots. The calcified shadow is usually irregular, seldom faceted. Each mass of glands may make up one spherical whole. These glands are generally multiple shadows but widely separated—too far to be within the gall bladder. On various films the same gland may have widely different positions, indicating much greater range of motion than gallstones could have. This is especially marked if some films are taken with the patient standing or supine for comparison with the usual prone films. Occasionally typical calcified gland shadows prove to be stones in the cystic duct.

Urinary calculi are often found on gall-bladder examinations and the character of

the calcified shadow is characteristic. Branching, hornlike, half-moon-shaped renal calculi or casts of the renal pelvis are easy enough, but certain ureteral stones in the upper end of the right ureter may cast faceted shadows which are more difficult to differentiate. The *lateral* view is always an aid in further eliminating suspicious shadows, as it places the calcification within the gall-bladder area—well to the anterior.

Visualization of Ducts—The cystic duct is most commonly visible but hepatic and common ducts are distinguishable on some of the roentgenograms and any of the ducts may be demonstrated if one wishes to follow along for a sufficient time, provided, of course, that the gall bladder has normal shadow intensity. The best time to outline the ducts is following the meal as the gall bladder contracts down and empties. Heister's valves are often strikingly shown.

Following operative removal of the gall bladder the patient may have a return of symptoms, whereupon the doctor may refer him for a Graham, fearing that new stones have formed in the ducts. There is occasionally sufficient dilatation of the ducts by a stone to make it seem as though a new

small gall bladder has reformed. We had a case in which two small cholesterol stones were demonstrated within the dilated remains of a cystic duct after cholecystectomy. The opaque bile outlined the two stones like the eyes of an owl. The case was operated upon and the findings were confirmed.

Kirklin (4) was the first to recognize tumors of the gall bladder and to differentiate them from stones. He maintains, and we support his conclusions, that benign growths, especially papillomas, are more likely to be seen along the margin of the gall-bladder shadow or in the mid-section of the fundus—seldom in the lower portion. The shadow defect is usually round, small in size, and maintains the same relative position on all the roentgenograms. At times these defects may be multiple, if so, they are never aggregate but more likely discrete, in contradistinction to gallstones. Many times these negative areas do not appear until the gall bladder has partially emptied. It is possible that they really have very little clinical significance, as most cases giving a definite defect show an intense gall-bladder shadow.

Adenomas give somewhat different findings from papillomas—the defect is nearly always at the tip of the fundus and is more likely to be slit-like in character rather than round. It varies in size but is per-

sistent in location. In adenomas the gall-bladder shadow is more likely to be somewhat faint, showing more pathologic changes in the walls, and is more frequently found as the gall bladder empties.

SUMMARY

(1) A new oral method of intensified cholecystography is presented based on fractional doses over a longer period of time, a fast Bucky, and the administration of glucose before and during examination.

(2) Consideration is made of certain errors due to the patient, and the roentgen technic is recounted in detail.

(3) Some easily misunderstood problems in interpretation are considered, such as "faint" and "no shadow" cases.

(4) A differential diagnosis has been compiled covering confusing intrinsic and extrinsic shadows, with remarks emphasizing the characteristics brought out by Kirklin on papilloma and adenoma of the gall bladder.

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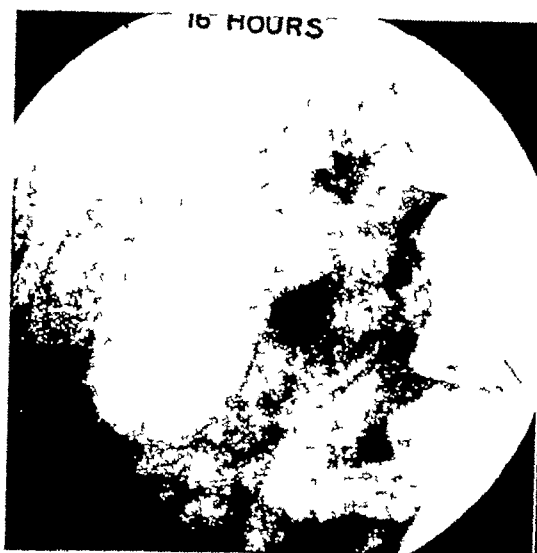


Fig 13. Case *F*. Note gall bladder shadow in the presence of calcified gallstones. Old technic, film taken 16 hours after tetraiodo



Fig 14. Case *F*. Note concentration of gall bladder even in the presence of numerous stones. Cystic duct patent. This film was taken 40 hours after first dose of tetraiodo. New technic

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cephalography is of value in cases of suspected tumor in which the signs of pressure are absent. It is necessary, however, at times to supplement ventriculography when the encephalographic findings are not conclusive, as stressed by Dandy and illustrated in three of the following cases.

Adson presented an excellent evaluation of this procedure in 1931 and I am taking the liberty to borrow his means of critical analysis.

The above ten cases had variable signs and points in each history which would

were explored and in six the encephalograms were found to have been of definite localizing value. In two instances (Cases 2 and 5) the localization was definitely misleading as no tumor was found. There was one instance (Case 8) in which the ventricles did not fill satisfactorily and subsequent ventriculography was necessary before a definite diagnosis could be made. The one death (Case 9) following encephalography was in a nine-year-old girl with a third ventricle tumor. The neurologic picture consisted of a child in coma who suffered from a bizarre type of convulsive seizures many times each day. Death occurred five days after encephalography and the tumor was found at autopsy.

TABLE II

Encephalographic studies	Diagnostic Value	Therapeutic Value and Comments
feet over right lobe	Positive	Exploration removal of clot
feet over left temporal lobes	Positive	Exploration removal of clot
rebral atrophy ated ventricles	Positive	No operation felt to be justified
feet over both lobes	Positive	Bilateral exploration with removal of clots
feet left temp	Positive	Exploration moved clot re
feet right parietal	Positive	Exploration removal of clot
encephalogram	Positive	No operation 120 c.c. of cerebrospinal fluid replaced with 110 c.c. air
log	Positive	No surgical procedure felt to be justified
one	None	None 90 c.c. of cerebrospinal fluid replaced with 85 c.c. air
terminate	None	None 110 c.c. cerebrospinal fluid replaced with 100 c.c. air
refus	None	None 80 c.c. cerebrospinal fluid replaced with 75 c.c. air
		None 90 c.c. cerebrospinal fluid replaced with 85 c.c. air
		None 110 c.c. cerebrospinal fluid replaced with 100 c.c. air
		None 80 c.c. cerebrospinal fluid replaced with 75 c.c. air
		None 90 c.c. cerebrospinal fluid replaced with 85 c.c. air
		None 110 c.c. cerebrospinal fluid replaced with 100 c.c. air
		None 80 c.c. cerebrospinal fluid replaced with 75 c.c. air

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THE VALUE OF ENCEPHALOGRAPHY AS A DIAGNOSTIC AND THERAPEUTIC AGENT

By WALTER D. ABBOTT, M.D., F.A.C.S., Des Moines, Iowa

THE procedure of encephalography as a diagnostic and therapeutic agent has become more popular in the past few years. As in all new ventures in medicine and surgery, extravagant claims have been made for the relative merits for this addition to our armamentarium.

There is no question but that encephalography has been of distinct advantage in certain conditions and guilty of providing misleading or worthless clues in pursuing the cause of other disease entities. Thus, it is the purpose of this paper to present a critical review of a series of cases, taken in consecutive order, and to discuss the relative merits of encephalography in each individual instance.

It seems unnecessary to repeat the history of the development of this procedure, with its gradual evolution into the present

technic, which is practically standardized. Thus, each type of disease condition in which the following cases have been applied will be briefly discussed.

Brain Tumors—There are certain instances in which the presence of an intracranial growth is suspected, with a paucity of localizing signs. No case of suspected brain tumor should be submitted to a mechanical means of diagnosis until every neurologic, ophthalmologic, and roentgenographic clue has been carefully investigated. There are, however, instances in which further efforts are indicated so that a proper diagnosis and localization can be made. It has been emphasized repeatedly that encephalography is dangerous in the presence of increased intracranial pressure as evidenced by choked discs and a high spinal manometric reading. Thus, en-

TABLE I

Clinical Diagnosis		Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Tumor suspected localized	not	Negative	Tumor right parietal lobe	Positive	Inoperable glioma of right temporal lobe
2 Tumor suspected localized	not	Negative	Filling defect posterior horn of right lateral ventricle	Misleading	None. Exploration no tumor found. Autopsy: meningococcal meningitis.
3 Tumor suspected localized	not	Negative	Tumor right parietal lobe	Positive	Inoperable glioma (spongioblastoma multiforme) right parietal lobe
4 Tumor suspected localized	not	Negative	Tumor right temporal lobe	Positive	Exploration. Aneurysmal varix right temporal lobe
5 Tumor suspected localized	not	Negative	Filling defect right lateral ventricle	Misleading	Exploration. no tumor found
6 Tumor suspected localized	not	Negative	Tumor left parietal lobe	Positive	Exploration. subcortical cyst
7 Tumor suspected localized	not	Increased pressure	Tumor right temporal lobe	Positive	Inoperable glioma (spongioblastoma multiforme) right temporal lobe
8 Tumor suspected localized	not	Increased pressure	Filling defect third and right lateral ventricles	None	Ventriculography necessary. Third ventricle tumor
9 Tumor suspected localized	not	Negative	Filling defect of third ventricle	Positive	Third ventricle tumor. Autopsy
10 Tumor suspected localized	not	Increased pressure	Tumor left frontal lobe	Positive	Exploration. Inoperable glioma left frontal and temporal lobes (spongioblastoma multiforme)

cephalography is of value in cases of suspected tumor in which the signs of pressure are absent. It is necessary, however, at times to supplement ventriculography when the encephalographic findings are not conclusive, as stressed by Dandy and illustrated in three of the following cases.

Adson presented an excellent evaluation of this procedure in 1931 and I am taking the liberty to borrow his means of critical analysis.

The above ten cases had variable signs and points in each history which would lead to a suspicion of brain tumor. In no case was there presence of choked discs or an increase of spinal fluid pressure above 20 cm. of water. Eight of the ten cases

were explored and in six the encephalograms were found to have been of definite localizing value. In two instances (Cases 2 and 5) the localization was definitely misleading as no tumor was found. There was one instance (Case 8) in which the ventricles did not fill satisfactorily and subsequent ventriculography was necessary before a definite diagnosis could be made. The one death (Case 9) following encephalography was in a nine-year-old girl with a third ventricle tumor. The neurologic picture consisted of a child in coma who suffered from a bizarre type of convulsive seizures many times each day. Death occurred five days after encephalography and the tumor was found at autopsy.

TABLE II

Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Suspected subdural hematoma following injury	Negative	Filling defect over right parietal lobe	Positive	Exploration removal of clot
2 Suspected subdural hematoma following injury	Negative	Filling defect over left fronto-temporal lobes	Positive	Exploration removal of clot
3 Suspected bilateral subdural hematomas following birth injury	Negative	Marked cerebral atrophy with dilated ventricles	Positive	No operation felt to be justified
4 Suspected bilateral subdural hematomas following birth injury	Negative	Filling defect over both parietal lobes	Positive	Bilateral exploration with removal of clots
5 Suspected subdural hematoma following injury	Healed fracture left temporal bone	Filling defect left temporal lobe	Positive	Exploration clot removed
6 Suspected hematoma following injury	Linear fracture left frontal bone	Filling defect right parietal lobe	Positive	Exploration removal of clot
7 Suspected subdural hematoma following injury	Linear fracture right parietal bone	Normal encephalogram	Positive	No operation 120 c.c. of cerebrospinal fluid replaced with 110 c.c. air
8 Suspected traumatic epilepsy	Negative	Normal encephalogram	Positive	No surgical procedure felt to be justified
9 Post traumatic head ache	Negative	Normal encephalogram	None	None 90 c.c. of cerebrospinal fluid replaced with 85 c.c. air
10 Post traumatic head ache	Healed fracture left frontal lobe	Moderate widening of cortical pathways over both frontal lobes	Indeterminate	None 110 c.c. cerebrospinal fluid replaced with 100 c.c. air
11 Post traumatic head ache	Negative	Normal encephalogram	None	None 80 c.c. cerebrospinal fluid replaced with 75 c.c. air
12 Post traumatic head ache	Healed fracture right parietal lobe	Slight dilatation of ventricles and compression sulci right parietal lobe	Indeterminate exploration refused	None 130 c.c. cerebrospinal fluid replaced with 120 c.c. air
13 Post traumatic head ache	Healed fracture right frontal bone	Slight widening of cortical pathways over both frontal lobes	Indeterminate	None 90 c.c. cerebrospinal fluid replaced with 85 c.c. air
14 Post traumatic head ache	Negative	Right lateral ventricle partially filled other wise normal	Indeterminate ventriculogram refused	None 75 c.c. cerebrospinal fluid replaced with 70 c.c. air

Thus, it is felt that occasionally, in a case of suspected brain tumor, encephalography is indicated when there are no demonstrable signs of a marked increase in intracranial pressure. However, the possibility of being misled in localization must be borne in mind and it is my opinion that ventriculography is of far more value in localizing cerebral neoplasms when clinical signs are insufficient.

Traumatic Conditions—The ever-increasing frequency of puzzling complications following head injuries may upon occasion warrant the use of encephalography for a means of diagnosis. In addition, a number of writers have reported beneficial results in unusually resistant cases of post-traumatic headaches. These gratifying rewards are based upon the theory that insufflation of air will break up many fine adhesions which had interfered with the normal circulation of cerebro-spinal fluid. This has not occurred in my experience, as will be shown in the following

cases. Many of these unfortunate sufferers are relieved only by generous compensation or through much reassurance over the course of many months.

Encephalography was of distinct diagnostic value in eight of the above cases and possibly of some value in four other cases. As a therapeutic agent directed toward relief of post-traumatic headaches, this procedure was of no benefit. It is important to state that in all of the above cases there was insufficient clinical evidence to warrant a diagnosis.

Congenital Defects—Every clinician is confronted with the problem of the defective child and its anxious parents. Pancoast and Fay, and later, Crothers, Vogt, and Eley have discussed the value of pneumoencephalography in children with fixed lesions of the brain. If for no other reason, encephalography, or preferably ventriculography, should be instituted to prevent dotting parents from wasting hard-earned money in a vain search for a cure of a hope-

TABLE III

Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Hydrocephalus	Not taken	Marked dilatation of ventricles and compression of both cerebral hemispheres	Positive	None. 200 c.c. cerebrospinal fluid replaced with 190 c.c. air.
2 Indeterminate	Negative	Ventricles not visible	Negative. ventriculography supplemented	None. Ventriculograms indicated lesion of third ventricle. Congenital defect of third ventricle found at autopsy.
3 Indeterminate	Negative	Defect of third ventricle	Positive	None. Corroborated at autopsy.
4 Indeterminate	Negative	Defect of fourth ventricle	Positive	Exploration. Anomalous vessels constricting fourth ventricle.
5 Hydrocephalus	Negative	Communicating hydrocephalus obstruction at chiasmatal cistern	Indeterminate. refused exploration	None. 150 c.c. cerebrospinal fluid replaced with 140 c.c. air.

TABLE IV

Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Headaches following encephalitis 2 years previously	Thin inner table left frontal bone	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (120 c.c.) replaced with 110 c.c. air. Relief with dehydration diet.
2 Headaches, emotional instability following encephalitis 2 years previously	Negative	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (90 c.c.) replaced with 80 c.c. air. Relief with dehydration diet.
3 Headaches following encephalitis 18 months previously	Negative	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (8, c.c.) replaced with 80 c.c. of air. Relief with dehydration diet.

lessly deficient child Encephalography does not seem as valuable as ventriculography in some cases of hydrocephalus, and for this reason it is sometimes necessary to supplement the latter procedure when doubt exists as to the presence of an obstruction in the ventricular circulation. It is highly possible that some of the fol-

lowing cases might receive benefit at a later date when our knowledge of newer surgical attacks upon the ventricles becomes broader

Inflammatory Conditions—There have been occasional cases following in the wake of a severe encephalitis in which the symptoms were bizarre and the physical

TABLE V

Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Epilepsy	Negative	Diffuse cerebral atrophy	Positive	None 180 c.c. cerebrospinal fluid replaced with 165 c.c. of air. Rapid mental deterioration.
2 Epilepsy	Negative	Communicating hydrocephalus block at chiasmal cistern	Positive	Exploration. Adhesions around chiasmal cistern broken up. Convulsions definitely diminished in severity and frequency.
3 Epilepsy	Negative	Normal encephalogram	Indeterminate	None 100 c.c. of cerebrospinal fluid replaced with 90 c.c. of air. No improvement.
4 Epilepsy	Negative	Compression of right parietal lobe	Misleading	Exploration for tumor none found. Meningo-encephalitis. Moderate improvement on dehydration diet.
5 Epilepsy	Negative	Normal encephalogram	Indeterminate	None 100 c.c. cerebrospinal fluid replaced with 95 c.c. of air. Placed on dehydration diet. Unco-operative. No improvement.
6 Epilepsy	Negative	Moderately diffuse cerebral atrophy	Positive	None 120 c.c. of cerebrospinal fluid replaced with 115 c.c. of air. Dehydration diet. Marked improvement.
7 Epilepsy	Negative	Diffuse cerebral atrophy	Positive	None 180 c.c. of cerebrospinal fluid replaced with 175 c.c. of air. Rapid mental deterioration.
8 Epilepsy	Negative	Wide cortical pathways	Positive	None 100 c.c. cerebrospinal fluid replaced with 90 c.c. of air. Marked improvement with dehydration diet.
9 Epilepsy	Negative	Moderate cerebral atrophy	Positive	None 120 c.c. cerebrospinal fluid replaced with 110 c.c. of air. Moderate improvement on dehydration diet.
10 Epilepsy	Negative	Normal encephalogram	Indeterminate	Indeterminate 80 c.c. cerebrospinal fluid replaced with 75 c.c. of air. Parents would not co-operate on diet. No seizures in past 18 months.
11 Epilepsy	Negative	Normal encephalogram	Indeterminate	None 80 c.c. cerebrospinal fluid replaced with 75 c.c. air. No co-operation on diet. Convulsions persist.
12 Epilepsy	Negative	Diffuse cerebral atrophy	Positive	None 100 c.c. cerebrospinal fluid replaced with 90 c.c. of air. Rapid mental deterioration.

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Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
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2 Indeterminate	Negative	Ventricles not visible	Negative (ventriculography supplemented)	None. Ventriculograms indicated lesion of third ventricle. Congenital defect of third ventricle found at autopsy
3 Indeterminate	Negative	Defect of third ventricle	Positive	None. Corroborated at autopsy
4 Indeterminate	Negative	Defect of fourth ventricle	Positive	Exploration. Anomalous vessels constricting fourth ventricle
5 Hydrocephalus	Negative	Communicating hydrocephalus; obstruction at chiasmatic cistern	Indeterminate (refused exploration)	None. 150 c.c. cerebrospinal fluid replaced with 140 c.c. air

TABLE IV

Clinical Diagnosis	Roentgenograms	Encephalographic Studies	Diagnostic Value	Therapeutic Value and Comments
1 Headaches following encephalitis 2 years previously	Thin inner table left frontal bone	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (120 c.c.) replaced with 110 c.c. air. Relief with dehydration diet
2 Headaches, emotional instability following encephalitis 2 years previously	Negative	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (90 c.c.) replaced with 80 c.c. air. Relief with dehydration diet
3 Headaches following encephalitis 18 months previously	Negative	Wide cortical pathways and compression of both frontal lobes	Positive	Cerebrospinal fluid (80 c.c.) replaced with 80 c.c. of air. Relief with dehydration diet

RENAL RICKETS¹

WITH REPORT OF A CASE

By BERNARD H. NICHOLS, M.D., and E. LEE SHIFLETT, M.D., *Cleveland Clinic, Cleveland, Ohio*

THE association of chronic kidney disease with renal insufficiency and delayed rickets in children and adolescents has been frequently stressed in the literature since Lucas, in 1883 (1), reported a number of cases of rickets associated with albuminuria. These occurred about puberty and he stated that the phenomena of late rickets and albuminuria are too frequently connected to be matters of chance and suggested for the ailment the term "rickets of adolescence." Fletcher's report (2) of a case of infantilism in a boy, aged six years, associated with chronic kidney disease, has been cited repeatedly as being the first definite recognition of the etiologic connection between chronic kidney disease and renal rickets. Barber, in 1920 (3), compiled a series of ten cases of stunted development, renal insufficiency, and the late bone changes of a rachitic nature and contributed the term "renal dwarfism." Thus were evolved the three terms used to describe the variable clinical manifestations of maldevelopment due to renal insufficiency in early life, the particular terms used depending on whether rickets, infantilism, or dwarfism is the predominant abnormality. The literature contains many case reports and the collected data have established renal rickets as a clinical entity.

Etiology—A sufficient number of cases and enough clinical and pathologic data have been collected to establish the fact that this type of rickets is not the result of any one particular type of chronic kidney disease but may be associated with chronic interstitial nephritis, cystic kidneys, congenital or acquired obstruction of the urinary tract, urinary tract infections and calculi, nephritis secondary to systemic or local infections which ter-

¹ Received for publication Oct. 17, 1934.

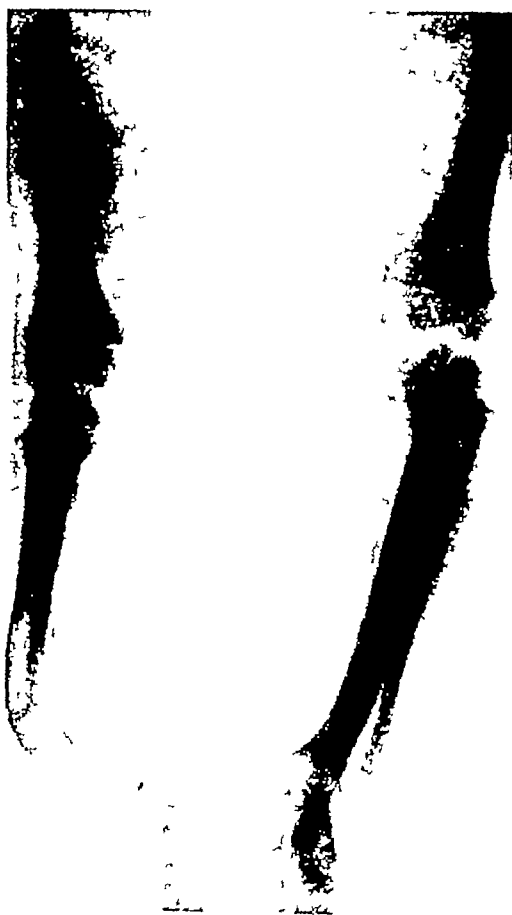


Fig. 1. Anteroposterior view of the legs shows marked bowing with cupping of the diaphyses of the lower end of the tibiae and broadening of the upper end.

minate in chronic nephritis, or other lesions which produce renal insufficiency during the growth period.

The mechanism by which the bony changes take place is not definitely understood and there are many controversial theories. Most of the theories are based on a disturbed calcium-phosphorus balance resulting from the inability of the kidneys to excrete endogenous phosphates. This presumably leads to an elevation of the blood phosphates and a lowered blood calcium. The lowered calcium and in-

findings were absent or out of proportion with the history. It is in these few instances that encephalography has been of value as a means of diagnosis which led to institution of treatment affording definite relief.

Epilepsy—Encephalography has been advocated as a diagnostic means in all cases of generalized convulsions. The supporters of the dehydration treatment feel that an encephalogram and measurement of cerebrospinal fluid content will regulate, to a relative degree, the amount of fluid restriction.

It is obvious that any adult suddenly seized with convulsions in the absence of a demonstrable cause or previous epileptic history, should receive the benefit of encephalography as a means toward detection of organic pathology.

There have been some reports that encephalography is of therapeutic value in the convulsive state, but it is questionable if this procedure is the sole therapeutic agent or if it is not an adjunct to other forms of therapy. Thus, it would be extremely difficult to evaluate the full benefit of encephalography unless a series of cases were kept under strict observation to rule out any additional form of treatment. In one of the following cases, the convulsions have ceased for eighteen months without further treatment purely because of uncooperative parents. Thus one case hardly

seems to justify a feeling of reliance upon encephalography as a sole therapeutic agent.

SUMMARY

Encephalography has been of value as a means of diagnosis in a large percentage of the above cases when clinical signs were too meager to clarify each situation. However, as in all mechanical aids, too much reliance cannot be placed upon this procedure. As a therapeutic agent, encephalography has been of no value in my experience.

To obtain the full benefit of encephalography, there must be a thorough basic understanding of the pathology of the cerebrum and knowledge of the physiologic anatomy of the cerebrospinal fluid circulation, coupled with close co-operation between the neurologist, surgeon, and roentgenologist.

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Fig 3 Outward bowing of both femurs. The diaphysis is markedly trabeculated and shows decreased calcium deposit.

tissue, irregular calcification and broad zones of loose connective tissue in which islands of osteoid tissue are embedded between cartilage and bone. The large islands of cartilage are bordered by dense calcium deposits which give to the bones the honeycombed and woolly appearance seen on the roentgenogram. The proliferative cartilage is irregular and calcification is defective. Trabeculae are thin and the osteoid borders are narrow. Loose fibrous tissue surrounds and lies between the trabeculae and islands of cartilage. The bone is soft and the cortex is thin. Hemorrhage may occur between the epiphyses and the diaphyses. There is a large increase in medullary fat.

Symptoms—Renal rickets usually appears before the tenth year, and is most common in children under five years of age. The onset is usually insidious. In-

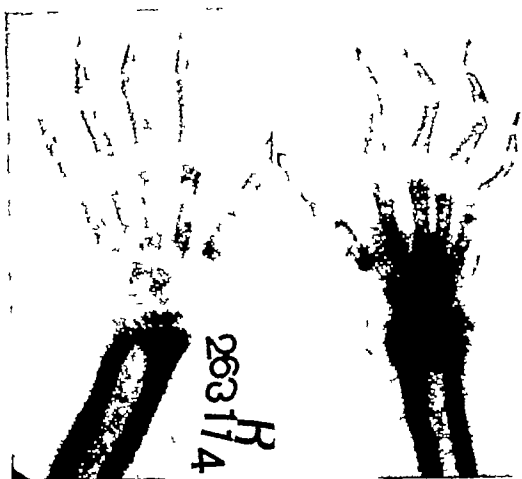


Fig 4 Delayed appearance of carpal bones, and scanty calcium content. There is broadening of the diaphyses of the radii and absence of calcification in the lower end of the ulnae.

fantilism, dwarfism, or rickets may be the outstanding clinical picture and there are combinations and variables of these abnormal states. The symptoms are chiefly those of a chronic nephritis on which are superimposed rachitic changes and maldevelopment. The symptoms are variable and not all those characteristic of the disease are present in every case. Drowsiness, headaches, vomiting, anorexia, excessive thirst, polyuria, wasting, anemia, impaired renal function, retardation of growth and physical development, delayed or absent development of the secondary sexual characteristics, and rachitic deformities are the predominant signs and symptoms. In view of the renal damage, there is a surprisingly low incidence of cardiovascular signs and symptoms. Hematuria, renal pain, dyspnea, palpitation, visionary changes, high blood pressure, and edema are by no means outstanding symptoms.

The chief physical findings are genu valgum, parietal and occipital bossing, beading of the costochondral junctions, Harrison's sulcus, flaring of the epiphyses, "pigeon chest," flat feet, bowing of the long bones, and occasionally deformities from malunited fractures and genu varus.

The urea and non-protein nitrogen in

creased phosphorus content may be relative or absolute, or there may be a complete reversal of the usual ratio of calcium

Pathology—The outstanding pathologic finding is marked, and often results in practically complete destruction of the

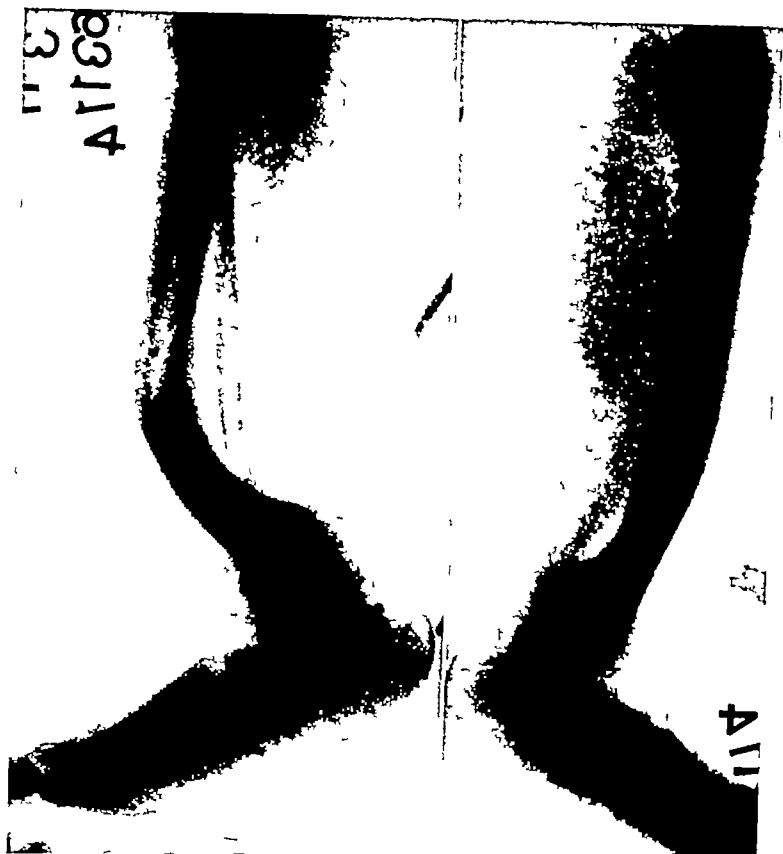


Fig 2 Lateral view of the legs shows marked tibial bowing and rachitic changes about the epiphyses

and phosphorus This abnormal calcium-phosphorus ratio seems to be entirely independent of the mineral and vitamin constituents of the diet, and hence renal rickets is not regarded primarily a food deficiency disease Mitchell (4) reasons that since the kidneys are unable to excrete the endogenous phosphates, the blood phosphorus should be higher than that usually found, and hence the body must be eliminating these waste products in some way, presumably by the bowel He believes that the increased level of phosphates in the intestines can interfere with the absorption of the calcium by the formation of insoluble calcium phosphates which are excreted in the feces

kidneys Grossly, the kidneys are small, fibrotic, and contracted, and the histologic picture is one of advanced chronic interstitial nephritis Associated pathologic findings in these cases include abnormal bone changes, renal and bladder calculi, hypertrophy of the heart, often associated with dilatation of the left ventricle, and sclerosis of the aorta and other large blood vessels

The gross deformities of bone are bowing, genu valgum, genu varus, widening of the diaphyses, thickening, displacement and partial epiphyseal separation, fractures, and malunion The microscopic changes in the bones consist of irregularity of the epiphyseal lines with islands of osteoid

was some cupping of the lower end of the tibiae (Figs 1 to 4)

The marked renal insufficiency was indicated by polyuria, low specific gravity of the urine, the presence of albumin, the low phenolsulphonephthalein output, the low urea clearance, and the failure of the kidneys to excrete the dye when an attempt was made to get an intravenous urogram. The blood urea was high and the calcium-phosphorus ratio was normal. Cardiac enlargement, increased blood pressure, and visionary changes were not present in this case.

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the blood are usually high. It is amazing that some of these children are able to carry on for years with a blood urea of 100 mgm per cent or more (5). The specific gravity of the urine is usually fixed at a low level. Albumin may or may not be present at single examinations, but repeated urinalyses will usually reveal albumin in variable amounts in one or more specimens. Bacteria and pus may or may not be present. Casts are not constantly found. The phenolsulphone-phthalein output is markedly decreased and urea clearance and other renal functional tests show marked impairment of function.

There is usually an abnormal calcium-phosphorus ratio. A normal ratio at one examination does not exclude renal rickets. There is a tendency to true acidosis which some have considered a protective mechanism against tetany.

Roentgenographic Findings—The roentgenographic appearance of the bones in renal rickets is not pathognomonic as is attested by the variety of descriptions and classifications found in the literature. The picture is more or less characteristic of infantile rickets, but Mitchell (4) has noted in renal rickets greater translucency and a more spongy appearance of the bones. The roentgenographic picture seems to depend upon the age of the patient at the time of onset of the disease and the stage of the disease at the time of the examination. The roentgen changes are generalized diminution of lime salts, increased trabeculation, poorly calcified subperiosteal bone, osteoporosis, irregular and patchy ossification which gives a woolly appearance, irregularity and expansion of the epiphyses, bowing of the long bones, and partial epiphyseal separations and displacement. The most marked changes are usually observed in the region of the growth discs. Cupping is observed in some cases. Although a given picture may vary greatly from that usually observed in infantile rickets, the roentgenographic appearance is not pathognomonic. The roentgenologist cannot make a posi-

tive diagnosis of renal rickets unless the roentgenographic findings are correlated with the clinical and laboratory data.

CASE REPORT

The patient, a little girl who was five years and eight months old when she was first examined at the Cleveland Clinic, had long-standing symptoms of renal insufficiency and rickets. She had had a local ear infection since she was a few weeks old, and nutrition had always been difficult as the result of the careless administration of concentrated hydrochloric acid when she was six days old. She had pneumonia at the age of one year from which she apparently had recovered satisfactorily. At the age of one year and eight months she had varicella, and at about the same time the parents had first noticed evidence of rickets.

The exact onset of the kidney symptoms could not be determined, and it is impossible to state whether she had true infantile rickets before the age of one year and eight months and later developed renal insufficiency which kept up the rachitic condition or whether the kidney insufficiency developed first. The latter is more likely, for, in spite of the dietary problem, through forced feeding the patient had received a sufficient intake of food and antirachitic vitamin. She had never had convulsions and apparently there had been no uremic symptoms although her blood urea had been known to be greatly increased for two years before she was admitted to the Clinic. Although this patient may have had true infantile rickets, it is definitely established that the factor of renal insufficiency prevented healing on an adequate diet and adequate amounts of antirachitic Vitamin D.

There was a secondary anemia. She displayed marked rachitic deformities and also deformity as a result of malunion. Roentgenographic examination showed defective calcification, poorly calcified periosteal bone, trabeculation, delayed appearance of carpal bones, and partial epiphyseal separation. In addition, there

6 All rooms should preferably be decorated in light colors

7 A working temperature of about 18° – 22° C (65° – 72° F) is desirable in x-ray rooms

8 X-ray rooms should be large enough to permit a convenient layout of the equipment. A minimum floor area of 250 sq ft (25 sq meters) is recommended for x-ray rooms, and 100 sq ft (10 sq meters) for dark rooms. Ceilings should be not less than 11 ft (3.5 meters) high

9 High tension generators employing mechanical rectification should preferably be placed in a separate room from the x-ray tube

III X-RAY PROTECTIVE RECOMMENDATIONS

10 An x-ray operator should on no account expose himself to a direct beam of x-rays

11 An operator should place himself as remote as is practicable from the x-ray tube. It should be borne in mind that valve tubes are capable of producing x-rays

12 The x-ray tube should be self-protected or otherwise surrounded as completely as possible with protective material of adequate lead equivalent¹

13 The following lead equivalents are recommended under average conditions

X rays generated by peak voltages		Minimum equivalent thickness of lead	
Not exceeding	75 K V	1	mm
	100	1.5	
	125	2	
	150	2.5	
	175	3	
	200	4	
	250	6	
	300	9	
	350	12	
	400	15	

(1) Diagnostic Work

14 In the case of diagnostic work with other than completely protected tubes the operator should be afforded additional pro-

tection from stray radiation by a screen of a minimum lead equivalent of 1 millimeter

15 Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures. Palpation with the hand should be reduced to the minimum

16 The lead glass of fluorescent screens should have the protective values recommended in Paragraph 13

17 In the case of screening stands the fluorescent screen should, if necessary, be provided with a protective "surround" so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm

18 Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient

19 Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than one-third millimeter lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of 0.5 millimeter

(B) Treatment

20 In the case of x-ray treatment the operator is best stationed completely outside of the x-ray room behind a protective wall of a minimum lead equivalent of 2 millimeters. This figure should be correspondingly increased if the protective value of the x-ray tube enclosure falls short of the values given in Paragraph 13. In such event the remaining walls, floor, and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances

21 Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall

22 In those cases in which an x-ray tube is continuously excited and treatment periods are regulated by means of a shutter, some form of remote control should be provided for the shutter to ensure that the

¹ The lead equivalent of a given thickness of protective material is that thickness of lead which is equally opaque to x rays excited at some specified peak voltage

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

Revised by the International X-ray and Radium Protection Commission at the Fourth International Congress of Radiology, Zürich, July, 1934

MEMBERS

Dr R Ledoux-Lebard (France), *Chairman*

Dr G W C Kaye (National Physical Laboratory, England), *Honorary Secretary*

Prof R Bar (Switzerland)

Dr H Behnken (Physikalisch-Technische Reichsanstalt, Germany)

Dr R Sievert (Sweden)

Dr I Solomon (Service d'Etalonnage de l'Hôpital St Antoine, Paris)

Prof F Tank (Switzerland)

Dr L S Taylor (National Bureau of Standards, U S A)

Dr E Pugno-Vanoni (Italy)

INTERNATIONAL RECOMMENDATIONS

1 The dangers of over-exposure to x-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of x-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are

- (a) Injuries to the superficial tissues,
- (b) Derangements of internal organs and changes in the blood

The evidence available at present appears to suggest that under satisfactory working conditions a person in normal health can tolerate exposure to x-rays to an extent of about 0.2 international roentgen (r) per day. On the basis of continuous irradiation during a working day of seven hours, this figure corresponds to a dosage rate of 10^{-6} r per second. The protective values given in these recommendations are generally in harmony with this figure under average conditions. No similar tolerance dose is at present available in the case of radium gamma rays

I WORKING HOURS, ETC

2 The following working hours, etc, are recommended for whole-time x-ray and radium workers

- (a) Not more than seven working hours a day in temperate or cold climates. For workers in tropical climates, shorter hours may be desirable
- (b) Not more than five working days a week, the off-days to be spent as much as possible out of doors
- (c) Not less than four weeks holiday a year, preferably consecutively
- (d) Whole-time workers in hospital x-ray and radium departments should not be called upon for other hospital service
- (e) X-ray workers, and particularly radium workers, should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general, and blood examinations. These examinations will determine the acceptance, refusal for, limitation, or termination of such occupation

II GENERAL X-RAY AND RADIUM RECOMMENDATIONS

3 X-ray departments should not be situated below ground floor level

4 All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible

5 All rooms should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than ten times an hour. Air inlets and outlets should be arranged to afford cross-wise ventilation of the room

that the safe should be provided with a number of separate drawers individually protected. The amount of protection should correspond to the values given in the following table, these values which are based on working conditions where there is proximity to radium may be reduced for larger working distances

Maximum quantity of radium element gm	Thickness of lead cm
0.05	5
0.2	8.5
0.5	10
1.0	11.5
2.0	13
5.0	15
10.0	17

33 A separate room should be provided for the "make-up" of screened tubes and applicators, and should only be occupied during such work

34 In order to protect the body from the penetrating gamma rays during the handling of radium, a screen of not less than 2.5 cm of lead should be used, and proximity to the radium should only occur during actual work and for as short a time as possible

35 The measurement room should be a separate one and it should preferably contain the radium only during its actual measurement

36 Nurses and attendants should not remain in the same room with patients who are undergoing radium treatment with quantities exceeding 0.5 gm

37 All unskilled work or work which can be learned in a short period of time should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding six months. This applies especially to nurses and those engaged in "making-up" applicators

38 Discretion should be exercised in transmitting radium salts by post. In the case of small quantities it is recommended that the container should be lined through-

out with lead not less than 3 mm thick. It is more satisfactory to transport large quantities by hand in a suitably designed carrying case

(B) Radon

39 In the manipulation of radon, protection against the beta and gamma rays has likewise to be provided, and automatic or remote controls are desirable

40 The handling of radon should be carried out, as far as possible, during its relatively inactive state

41 Precautions should be taken against excessive gas pressures in radon plants. The escape of radon should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan controlled from the outside of the room

42 Where radon is likely to come in direct contact with the fingers, thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise, the protective measures recommended for radium salts should be carried out

43 The pumping room should preferably be contained in a separate building. The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium solution in a lead-lined box, the thickness of lead recommended being according to the table in Paragraph 32

(C) Tele-curie-therapy

44 It should be especially pointed out that the use of large quantities of radium in tele-curie-therapy may involve the risk of considerable dangers to the operators unless proper precautions are taken²

² The Commission welcomes information from those having special experience in this branch of radium treatment

operator is not exposed to direct radiation while manipulating the shutter or filter

Efficient safeguards should be adopted to avoid the omission of a metal filter in x-ray treatment. To this end, some means of continuously measuring the emergent radiation is recommended

IV ELECTRICAL PRECAUTIONS IN X-RAY ROOMS

23 The floor covering of the x-ray room should be of insulating material such as wood rubber, or linoleum

24 Where permanent overhead conductors are employed they should be not less than 9 ft (3 meters) from the floor, and should consist of stout metal tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire kept taut by suitable rheophores

25 Wherever possible earthed guards or earthed sheaths should be provided to shield the more adjacent parts of the high tension system. Unshielded leads to the x-ray tube should be in positions as remote as possible from the operator and the patient. The use of "shock-proof" x-ray equipment in which the high tension circuit is completely enclosed in earthed conductors is recommended. In all cases, however, indiscriminate handling of x-ray tubes during operation should be forbidden. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed

26 Main and supply switches should be very accessible and distinctly indicated. They should not be in the proximity of the high tension system, nor should it be possible for them to close accidentally. The use of quick-acting, double-pole circuit breakers is recommended. Over-powered fuses should not be used. If more than one apparatus is operated from a common generator, suitable high tension multi-way switches should be provided. In the case of some of the constant-potential generators, a residual charge is held by the condensers after shutting down and

a suitable discharging device should therefore be fitted. Illuminated warning devices which operate when the equipment is "alive" serve a useful purpose. The staff should be trained in the use of first-aid instructions dealing with electrical shock. If foot switches are used, they should be connected in series with an ordinary switch and should be so designed that they cannot be locked to keep the circuit "alive," and are not capable of being closed accidentally

27 Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the x-ray tube

28 Low flash-point anesthetics should never be used in conjunction with x-rays

V FILM STORAGE PRECAUTIONS

29 The use of non-inflammable x-ray films is strongly recommended. In the case of inflammable films, suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores, preferably in a separate building or on the roof

VI RADIUM PROTECTIVE RECOMMENDATIONS

(A) Radium Salts

30 Protection for radium workers is required from the effects of

- (a) Beta rays upon the hands,
- (b) Gamma rays upon the internal organs, vascular, and reproductive systems

31 In order to protect the hands from beta rays, reliance should be placed, in the first place, on distance. The radium should be manipulated with long-handled forceps, and should be carried from place to place in long-handled boxes, lined on all sides with at least 1 cm of lead. All manipulations should be carried out as rapidly as possible

32 Radium, when not in use, should be stored in a safe as distant as possible from the personnel. It is recommended

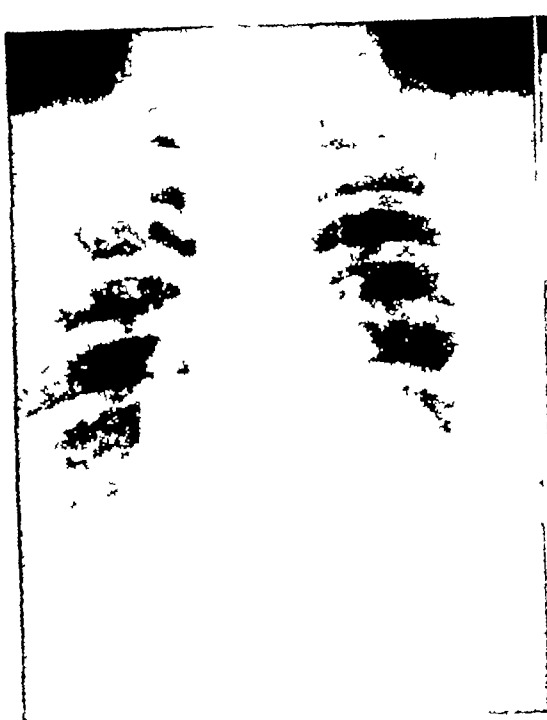


Fig 1 A 27 year-old white woman, with no history of exposure. Minimal productive lesion at first interspace on the right.

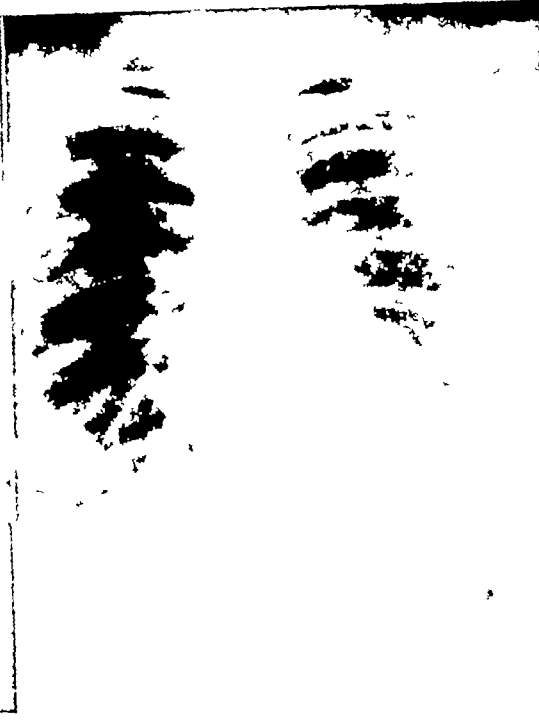


Fig 2 Same case as in Figure 1, one year later. Lesion healed with fibrosis following phrenic operation.

can produce in the line of disease or abnormality has a definite density representation in the film. It is there, whether we see it or not. In some aspects, a roentgenogram surpasses the gross postmortem examination, in the fact that the air chambers and bronchioles are shown during their physiologic function and the air-filled spaces produce contrast for the pathologic conditions which may exist, whereas at the postmortem, all tissues of the lung are more or less sunken and collapsed and the process of decay already at work. In short, any alteration in the normal physiology of the lung will, in most instances, produce rather definite x-ray changes which we learn to recognize and identify. We have but to remember our knowledge of ten years ago—how hopelessly we then fumbled about for the proper classification of the things we saw—and how confident we feel to day in naming the same lesions. I do not wish to infer that our knowledge of pathology was so much at fault at that

time, but our comparisons with post-mortem findings and the much improved technic of producing suitable roentgenograms are together responsible for the rapid strides made. So that, at the present time, we roentgenologists will probably have no more arguments in identifying lesions than do the pathologists. The matter of judgment based on experience will always enter in, regardless of how mathematically correct densities of different pathologic conditions may be recorded in our roentgenograms.

The exudative lesion is one with considerable perifocal inflammation. It is the acute form of tuberculosis and consists of small bronchopneumonic patches. The size and contour of the various patches vary considerably—some are circular and well defined, others are poorly defined and show a very ragged outline, but they all show that soft density of consolidation. When clearing and absorption take place, the perifocal exudate absorbs quickly

A ROENTGENOLOGIST'S VIEW OF THE MINIMAL TUBERCULOUS LESION

By C C BIRKELO, M D , Roentgenologist at Herman Kiefer Hospital and Maybury Sanatorium, *Detroit, Michigan*

THE definition of the minimal pulmonary tuberculous lesion outlined by the National Tuberculosis Association, is that lesion which would occupy an apical area and a first interspace on one side, as its maximum limitations, without excavation

The area of lung involvement may naturally be much smaller, or it may consist of several small areas of tuberculous infiltration, whose total space would no more than fill the above-mentioned maximum space. This classification does not include the childhood type of tuberculous infection, which may or may not show a parenchymal involvement, as well as lymph node enlargement or calcification. The supposition is that the process is active but definitely confined to the above-mentioned small space. Cavitations are not allowed in this classification, so that it becomes evident that few minimal lesions show any positive sputum. Most of them are exposure cases and the majority give very few, if any, symptoms, and would likely pass unnoticed if it were not for the x-ray examination. For this reason, the roentgenologist carries a great responsibility toward this type of lesion. He must know the physiology and anatomy and all variations within normal limits, as well as the common and rare pathologic lesions likely to occur in the lungs.

It is clearly evident that the earlier a tuberculous lesion can be definitely diagnosed, the better the chance for a more permanent repair. Complete eradication of the disease is not within our vision as yet, but how close we come to such an ideal will depend on how well we succeed in recognizing the first signs of pulmonary tuberculous disease or the minimal lesion.

Our x-ray department at Herman Kiefer Hospital has for many years served as a clearing house for all cases of discovered or

suspected pulmonary tuberculosis in our metropolis. In the past four to six years, the volume of chest x-ray examinations has grown to tremendous numbers. In 1929 we made 14,216 examinations and in 1933 we made 22,133. It is our duty to find the earliest forms of the disease, as well as those cases with advanced lesions, and also to eliminate those cases that do not have the disease.

The most common non-tuberculous lesions which we encounter in this survey are bronchiectasis, bronchopneumonia, pneumoconiosis, mitral stenosis, and malignancy of the lung. All of these lesions have rather definite x-ray findings, so that they are usually identified at once and tuberculosis definitely ruled out. Just as surely as these above-mentioned non-tuberculous diseases have definite x-ray characteristics, so does also the tuberculous lesion have definite x-ray findings. I could easily assemble many cases of tuberculous and non-tuberculous lesions which look very much alike, and yet, the distinguishing features or signs are there, if properly interpreted, and it is up to us as roentgenologists to see them and know them. I know of no better way to accomplish this knowledge than the actual experience gained from seeing pulmonary tuberculosis in all its varied forms.

Let us first consider an orderly method to attack the problem of diagnosis of the minimal lesion. There are two main types of minimal lesions, namely, the exudative and the productive, and these two types are almost as distinctly differentiated from a roentgenogram properly made as they are differentiated in the gross post-mortem examination. I have often been impressed with the similarity of a well-made roentgenogram of the chest and a cross-section of the lung at the postmortem table. Nearly everything the pathologist

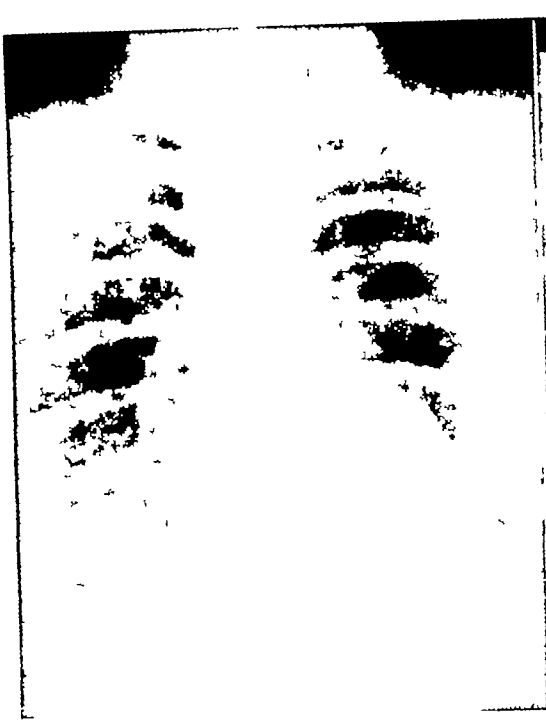


Fig 1 A 27 year-old white woman, with no history of exposure. Minimal productive lesion at first interspace on the right

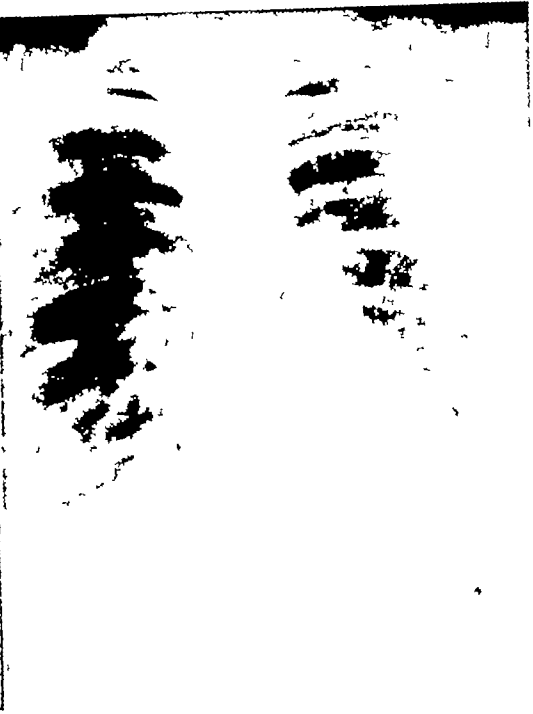


Fig 2 Same case as in Figure 1, one year later. Lesion healed with fibrosis following phrenic operation

can produce in the line of disease or abnormality has a definite density representation in the film. It is there, whether we see it or not. In some aspects, a roentgenogram surpasses the gross postmortem examination, in the fact that the air chambers and bronchioles are shown during their physiologic function and the air-filled spaces produce contrast for the pathologic conditions which may exist, whereas at the postmortem, all tissues of the lung are more or less sunken and collapsed and the process of decay already at work. In short, any alteration in the normal physiology of the lung will, in most instances, produce rather definite x-ray changes which we learn to recognize and identify. We have but to remember our knowledge of ten years ago—how hopelessly we then fumbled about for the proper classification of the things we saw—and how confident we feel to-day in naming the same lesions. I do not wish to infer that our knowledge of pathology was so much at fault at that

time, but our comparisons with post-mortem findings and the much improved technic of producing suitable roentgenograms are together responsible for the rapid strides made. So that, at the present time, we roentgenologists will probably have no more arguments in identifying lesions than do the pathologists. The matter of judgment based on experience will always enter in, regardless of how mathematically correct densities of different pathologic conditions may be recorded in our roentgenograms.

The exudative lesion is one with considerable perifocal inflammation. It is the acute form of tuberculosis and consists of small bronchopneumonic patches. The size and contour of the various patches vary considerably; some are circular and well defined, others are poorly defined and show a very ragged outline, but they all show that soft density of consolidation. When clearing and absorption take place, the perifocal exudate absorbs quickly



Fig 3 A 23 year-old white girl, with a definite history of exposure. Minimal mixed lesion in left infraclavicular region.

Fig 4 Same case as in Figure 3 one year later. Lesion completely absorbed following hospitalization.

and the actual size of the tuberculous lesion may then be found to be much smaller than was originally imagined.

This type of lesion is very dangerous and it may extend rapidly and pass from a minimal lesion to a far advanced process if it is not put under control. In other words, as soon as the lesion is identified, all our forces of combat should be properly marshalled and a suitable method of attack selected and immediately applied. Careless waiting and inaction can result only in disaster, both to the patient and to the reputation of the roentgenologist. This type of lesion has often been compared with pneumonia in acuteness and rapidity of its attack and extension. It is indeed acute, but it does not resemble pneumonia in the time involved in producing appreciable consolidation, or in any other way. We have here records of all varieties of lesions: those which rapidly increased or spread as well as those which rapidly improved. The reason we find what appears to be acute pneumonic types

of tuberculosis is, in most instances, because an early study has been neglected and undertaken only when the patient is incapacitated.

In the past three years we have examined roentgenograms of 13,000 school children, finding among them several cases of well-developed minimal and moderately advanced tuberculous lesions, often highly exudative in type, but in no one instance have we encountered extensive or massive consolidations, commonly called fulminating types of tuberculous lesions. If any tuberculous lesion, regardless of its type, comes on with the suddenness of pneumonia, I have never seen it, and I feel that statements to the contrary are exaggerations of actual facts. That it may develop rapidly and show extensive spread in a few weeks or a few months, is both true and a common experience here. It is in this exudative type in which such changes do occur.

The second class of lesion is the productive type. As its name implies, this is



Fig 5 A 13 year-old colored girl, with calcifications on both sides Exudative infiltrations in the left apical region



Fig 6 Same case as in Figure 5 seven months later, showing extensive involvement in the upper third of the left lung with excavations and positive sputum

the lesion which shows very little perifocal inflammation, but does show some fibrosis or scar formation. This is the lesion which forms the basis for the former opinion that tuberculous lesions are tremendously slow, both in their spread and progress, as well as in clearing or healing. This type of lesion usually leaves some scar by which we may later identify a previous lesion. It also is the cause of the earlier opinion that, once a tuberculous lesion has existed, some identifying scar or mark will result and always remain. Now we feel that we can as truthfully state that an exudative lesion in the adult will often clear as completely as a chronic fibrotic type will leave a scar (Figs 1 and 2, 3 and 4).

Then, when this type of lesion is encountered, we know that the condition is not so acute and that we have more time on our hands for deliberation. One thing is certain, that both types of lesions are capable of great damage or extension, with bad results if neglected or unrecognized, and, with neglect, a chronic pro-

ductive lesion may easily become both acute and exudative. The important problem still remains in the early recognition of the minimal lesion.

It should be of interest at this time to show how much, if any, improvement we are making in our attempt at an early diagnosis. Table I shows the classification of cases entered at Herman Kiefer Hospital in the various years.

TABLE I

	Minimal	Moderately advanced	Far advanced
1921	10 1%	14 4%	75 5%
1926	10 0%	14 5%	75 5%
1931	13 3%	25 1%	61 6%
1932	15 4%	28 6%	56 0%
1933	15 4%	32 5%	52 1%

This shows a slow but gradual increase in the number of minimal cases entered at the expense of the other classifications, particularly the far advanced. It is very encouraging and probably universally true, especially in this country, that a slow but gradual improvement is under way, and it need not be doubted that these results are obtained only by constant and un-



Fig 7 A 6 year-old white boy, with history of exposure Note small circular infiltration at left base with small central calcification

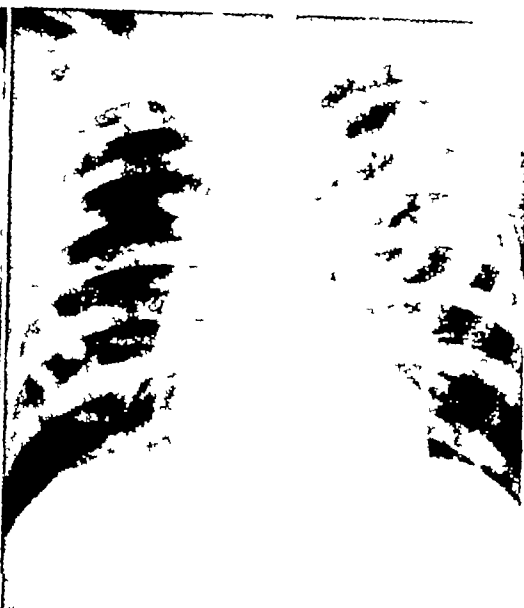


Fig 8 Same case as in Figure 7, three years later Calcification process at left base is complete

tiring efforts of the medical profession in educating the public in the need of early diagnosis

During the period from 1930 to 1934, we examined a number of cases of exposure and positive tuberculin reactors (Table II), in the Out-patient Clinic of this hospital, finding the number of tuberculous cases indicated and the number and percentage of minimal lesions, as shown

TABLE II

	No of cases examined	Minimal	Percentage
1930	17,327	301	15.2%
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From these figures we may reasonably assume that the percentage of minimal cases found is slowly but surely increasing and mostly at the expense of the far advanced cases, which dropped from 55.3 to 48.8 per cent in the same time period

To determine the location of minimal lesions in the lung, 300 cases were reviewed and all but 5 per cent were found in the

upper third of either lung, with very nearly equal frequency on the right and left sides. Supraclavicular lesions were not uncommon but more often combined with first interspace lesions. It is generally recognized that supraclavicular lesions are less likely to extend downward and spread than are other lesions, like the infraclavicular type. I should like to add that this is true in the productive type of lesion and not in the exudative type, as I have quite a number of cases on record showing a definite downward spread from a purely supraclavicular lesion (Figs 5 and 6).

Mid-lung lesions and also basal lesions are rare in the minimal class and usually found in reinfection or extensions from the childhood type of disease. The safest statement to make is perhaps this, that middle and basal lung lesions usually represent extensions from above and are often more advanced tuberculous lesions.

I have often been asked at what age period the greatest number of minimal lesions occur. Our statistics on this point differ from year to year and this question,

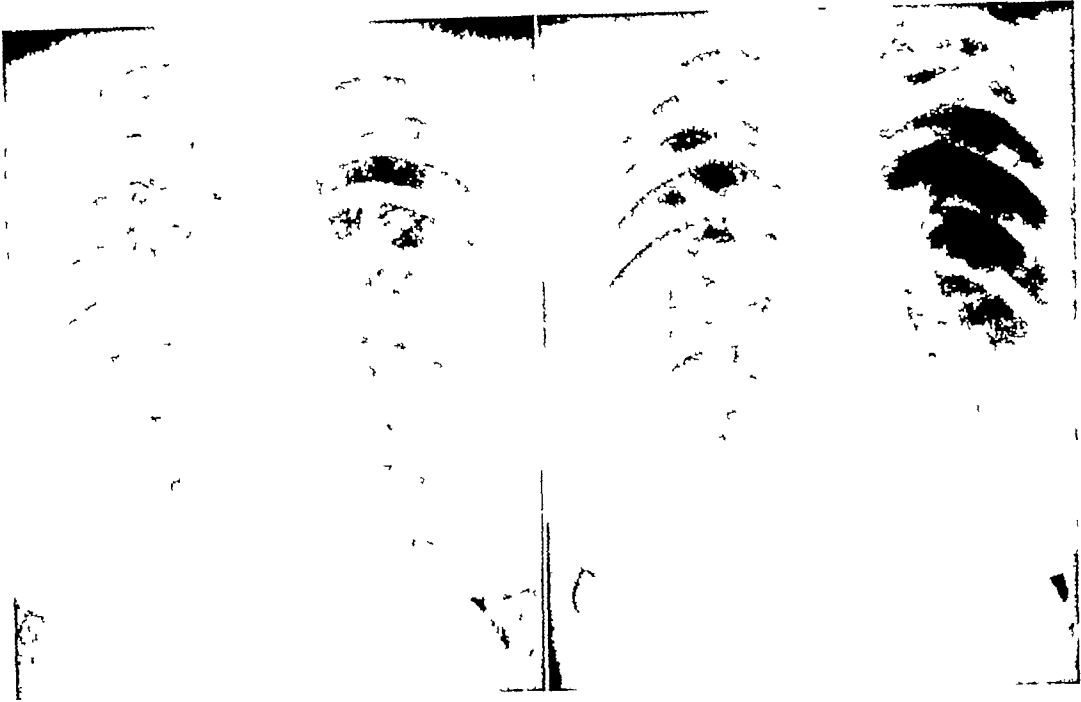


Fig 9 A 15-year-old white school girl, with no history of exposure Left apical, circular, exudative lesion, showing the beginning of excavation

Fig 10 Same case as in Figure 9, about a month later Lesion is the same in size but the cavity is larger

as well as the question of acuteness of the disease, can best be answered in this way the minimal lesion may occur at any age and its acuteness undoubtedly depends on the dosage of the tubercle bacilli received. One of the most acute cases I have ever observed was in an employee who had worked here for twenty or more years and was about 55 or 60 years old at the time. He became acutely ill and the first x-ray examination showed no disease, while in a matter of two or three weeks he had an extensive miliary infiltration of both lungs. The dosage of bacilli which found its way into his blood stream had undoubtedly been great, and surmounted all his powers of resistance. The toleration dose for any individual may, and undoubtedly does, change from time to time, inasmuch as we have many cases of exposure that are free from disease at the first examination, yet at a second and third examination show definite evidence of either active or healed lesions. They were undoubtedly as much exposed at the first

examination as they were later, when they knew about the source of infection, and yet, a period came when the resistance was sufficiently low for the disease to gain a foothold.

I also call to mind a far advanced case discovered after about a third of a lung had excavated. This patient's brother had occupied the same bed with him from childhood and yet had no tuberculosis or signs of any former infection, such as a calcification, after a two-year period of repeated examinations. The brother, who is free from tuberculosis, has always been vigorous and in excellent health, whereas the one with the far advanced lesion has never been strong. His source of exposure, as far as we could learn, was a fellow-workman with whom he was friendly, but they were not sufficiently friendly to visit each other after working hours. The other eight members of this family are also in good health and have not shown any signs of active or healed tuberculosis in the two-year period under observation.



Fig 7 A 6-year-old white boy, with history of exposure. Note small circular infiltration at left base with small central calcification.



Fig 8 Same case as in Figure 7, three years later. Calcification process at left base is complete.

tiring efforts of the medical profession in educating the public in the need of early diagnosis.

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other hand, I remember distinctly the cases of two girls who had formed extensive calcifications of bilateral extensive tuberculous lesions, and both came down with generalized blood-borne re-infection and passed out, in spite of all attempts at treatment. This disaster occurred at the puberty period in both instances, and the change in physiology occasioned at this period had probably a good deal to do both with the re-infection and the end-result. Here the calcifying processes could not have been complete, although they appeared very dense.

The great majority of our minimal lesions heal with fibrosis. The fibrous scar may or may not absorb quite completely, depending on its density and size. From the density and appearance of the fibrosis, it is quite possible to judge with a fair degree of accuracy as to the possible activity of a given lesion, and such an opinion, when found to be accurate, is indeed a great help in regulating the treatment to be given. It is this ability to judge a lesion from its appearance which makes it possible to empty hospital beds and make room for other patients in greater need of hospital care. We have long ago given up the idea of letting rest in bed be the proper treatment and I think our results will prove the correctness of this view.

At a regular conference, each case hospitalized is brought up for disposition as well as classification and the treatment decided upon is the one which will yield the quickest result. I have charted the minimal cases in the Herman Kiefer Hospital for the past five years and the diagram speaks for itself. Unless their home conditions were exceptionally good, all cases that were sent away from the hospital went to convalescent homes for longer rest periods. The active treatment decided upon was given here and it must have been sufficient, because we have very few of these cases that have come back to us later with more tuberculosis.

TABLE III—MINIMAL CASES AT HERMAN KIEFER HOSPITAL

Year	No cases entered	Average age	Average no days in hospital	Im-proved	Ar-rested	Unim-proved
1929	27	32 5	75	22	0	5
1930	131	30	103	96	17	18
1931	172	25 5	89	126	15	31
1932	158	27 5	105	118	18	22
1933	166	28	95	121	24	21

The lesions which disappear entirely are usually of the exudative type. These are the most dangerous and should receive some active treatment, such as a phrenic operation, and I feel free to state that the future will demand at least that much assistance be given each patient with such a lesion, no matter how small.

The size of the lesion should really have no weight in making a diagnosis of tuberculosis. I have watched very minute lesions in the parenchyma heal with fibrosis and calcification, proving my original diagnosis. I feel a great deal like the bacteriologist who has learned to identify his bacteria from colony characteristics. We have such colony characteristics of the tubercle bacillus in the lung, and we should be able to recognize them regardless of size (Figs 9 and 10). I am not presenting this as something new, because I am sure the majority of roentgenologists are conversant with all that I have suggested, but these days we have such a variety of specialists, each holding up a roentgenogram, each one feeling fully competent of pointing out all that is there—and are they? Not so long ago, a physician practising another specialty was showing a beautiful series of bronchiectasis with lipiodol injection, and casually made the statement that the x-ray films made without lipiodol showed just nothing. As a matter of fact, nearly all of these films showed evidence of bronchiectasis and had been so interpreted.

It is such statements as these, carelessly made, which we have to disprove and live down. We see so much at present about the early detection of tuberculosis with the fluoroscope, and I certainly wish to

In this family there must have been a continuous and generous dosage of infection for every member, in the year and a half during which the tuberculous brother must have had the infection, because when I first examined him he coughed considerably and raised generously and the material was loaded with bacilli in each specimen examined.

From many such experiences, it is reasonable to conclude that what is a safe dose to-day may not be safe to-morrow. We are all shocked at the tremendous ravages made by tuberculosis among the colored people, but there is a valid explanation for this in the fact that their living conditions are nearly always the worst in any city. Their daily dosage of tubercle bacilli is probably over and beyond our imagination.

Some years ago, I participated in a campaign against smallpox in the course of which a house-to-house canvass was made through the colored districts, to locate those unprotected individuals. It was found that several families not only occupied the same house, but slept in relays in the same bed, so that three families would sleep eight hours each in it. Now, then, is it past our imagination to understand why these people get an over-exposure or an over-dose of tuberculosis, if some one member of any of these families has an active excavating tuberculous lung involvement?

It has never been proven to my satisfaction that any one family, group, or race has any more resistance toward tuberculosis than any other. I think it has been pretty well shown that children of tuberculous parents do not suffer any more frequently from tuberculosis than do others, after they have once been removed from their source of infection.

This brings up the questions, When are sources of infection removed from a person's own system, once tuberculosis has been there? What can we tell with our x-ray examination or any other means at our disposal about the completeness of any healing process?

There are several ways in which a pulmonary tuberculous lesion may heal by calcification, by formation of fibrosis or scar tissue, or by complete absorption of the entire lesion. Calcification is certainly confined to the first two decades of life and it is indeed very rarely found in the adult. During these past years of seeing a tremendous number of tuberculous lesions and re-examinations at regular intervals, I recall only three cases in which healing by calcification occurred in the adult. Two of these patients were in their twenties and one was over thirty years old. All of them showed extensive blood-borne seedings in both lungs which healed by calcification in about a year or so. So, then, we can safely state that this type of repair or healing belongs in the early years of life, just as the calcifying process which goes on in epiphyseal cartilage, and again directly opposite to the age period when the costal cartilage calcifies. Why this process of repair is confined to this age period is not known, and it bears no direct relation to any diet or other physiologic factors so far discovered. Calcifications are both common and extensive in the colored people, but apparently no more so than in the whites, given equally extensive lesions. There has been much controversy about the safety of a calcified area as regards a possible source of re-infection.

We have often observed very small and early deposits of calcium form about a small lesion and also in the center of a lesion, and, as time passes, the entire lesion becomes calcified. Later some absorption takes place, leaving a small solid mass of bony density (Figs 7 and 8). Before this process is complete, it is naturally a source of possible re-infection. We also know that tubercle bacilli may be found in calcifications five or ten years following the first calcium deposit. The general rule which we have adopted of regarding a calcified lesion as safe, when the patient is past twenty years, works out very well, and I know of no instance in which such a re-infection has actually occurred, after this period of life. On the

ENCEPHALOGRAPHY IN ALZHEIMER'S DISEASE

By WILLIAM C. MENNINGER, M.D. the Menninger Clinic, Topeka, Kansas

THE clinical entity known as Alzheimer's disease was first described by Alzheimer (1), in 1907, in a pathologic study of brain changes occurring in a mental disorder in the presenile period. The disease process was subsequently named after him by Kraepelin, and has been the object of much study and many reports since the original description. It was originally regarded as a presenile psychosis because of the close resemblance of the pathologic changes to senile brain changes. The great majority of reported cases are in the fifth, sixth, or seventh decade of life, although the same clinical and pathologic picture has been reported in a woman of 31 by Barrett (2), in 1913, and in a boy of 15 by Malamud and Lowenberg (3), in 1929. Other cases reported as Alzheimer's disease (by Schnitzler, patient aged 32, Schaffer, patient aged 28, and Weimann, patient aged 37) are not generally accepted as typical of the disease (Gruenthal, 4). Lowenberg and Rothschild (5), in 1931, reported an atypical case with onset at 37 years of age which was regarded as toxic in origin.

In a special consideration of the etiology of Alzheimer's disease, Malamud and Lowenberg (3) conclude that this clinico-pathologic syndrome may be caused by a variety of factors, the chief of which may have something in common with that which is causative of such changes in senility. This does not exclude, in their opinion, the possibility that factors altogether independent of senility may also bring about the same condition. Arteriosclerosis and syphilis bear no relation to the disease.

TYPICAL FINDINGS IN THE DISEASE

As was pointed out by Gruenthal (4), the clinical findings are remarkably constant in even a large group of cases.

Mental Picture—The mental symptoms are usually the first evidence of the dis-

ease, which appears with a very gradual onset. Forgetfulness is characteristically the first symptom and soon the patient begins to mislay articles and to lose his belongings. The patient may be aware of his inability to think accurately and quickly and often he is concerned with the nature of his mental change. The memory loss progresses to confusion, with the frequent further handicap of apraxia and aphasia. Emotional instability is often conspicuous, with the occurrence of irritable periods and temper outbursts interspersed with periods of mild euphoria. The mental picture progresses to complete mental failure.

Neurologic Picture—The most characteristic of the neurologic findings are the aphasia and apraxia which are often more marked on one side than on the other. Convulsions are not infrequently reported and focal signs are common, particularly hemiplegia, bulbar disturbances, and muscular atrophy.

Pathologic Picture—Grossly there is brain atrophy, even to a difference of 20 per cent between the brain volume and skull capacity. Lowenberg and Rothschild (5) demonstrated a marked hemiatrophy of the brain at autopsy in one of their cases, a finding similar to the case presented here, as shown by encephalography. Microscopically there is a rarefaction of the cortical cell layers, a tremendous number of senile plaques (in direct proportion to the clinical severity of the disease), and a neurofibrillar degeneration (Grinker, 6).

THE USE OF ENCEPHALOGRAPHY

As has been indicated, the occurrence of focal signs in this disease is common. No doubt in many instances the diagnosis is somewhat uncertain because of the signs, particularly in instances of unilateral distribution. It is highly desirable to rule out a focal disturbance such as a

issue a protest in this regard. That is not the ideal way to wage a campaign against the early tuberculous lesion. We tried it here and had to give it up, and I both know and feel that I need all the very best film can show up to make a proper interpretation, the fluoroscope does not show enough. It is not safe to eliminate as non-tuberculous, those patients who show no fluoroscopic signs or findings.

With so many commercial organizations practising medicine in the most frugal manner, we will have such things to contend with. It is this sort of thing that makes it necessary to send out a plea for the recognition of the minute tuberculous lesion, as I am now doing. It must not be passed up.

SUMMARY

1 The striking resemblance between a postmortem cross-section of a lung and a well-made x-ray of a lung is worthy of special notice.

2 The minimal lesion is the most important tuberculous lesion of all, because it has a definite promise of a complete cure.

3 Learn to recognize the different varieties of minimal lesions in order to give the best possible advice to the referring physician.

4 Learn the favorite sites for a tuberculous lesion in the lung and make use of all probable factors in supporting your opinion, as it is often almost as detrimental to a young life to have a diagnosis of tuberculosis mistakenly attached as it is to have the early lesion missed.

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irritability As her confusion increased, her depression decreased

The family noticed that she seemed to go to the left of things and used her left hand much more than she did her right They noticed that she would make mistakes and when, asked for a knife, she would often give a fork She would put sugar in her coffee with the handle of her spoon rather than with the bowl, and occasionally would appear impatient with the difficulty she was having in using her eating utensils and eat directly with her fingers They noticed that she often had difficulty in finding words to express herself

Physical Examination—The patient was an obese, white female, unco-operative and objected throughout the examination to the various tests Weight 213 pounds, height 5 feet, 3 inches The conspicuous pathology noted was a red, dry tongue, hypertrophied tonsils, moderately enlarged heart with faint sounds, lacerated cervix, blood pressure 164/90, pulse rate 90, and the excessive obesity, particularly marked about the trunk

Neurologic Examination—The cranial nerves showed no gross pathology The right fundus showed extreme thinning of the arteries and in the left disc there was a slight haziness in a small arc on the nasal border The pupils reacted promptly to light and accommodation in a very slightly restricted radius The right nasolabial fold was slightly shallower than the left, and the right-hand grip was a shade weaker than the left In the motor system there was no gross pathology except as noted in the performance of skilled acts There was no disturbance in gait, no paralysis, and no change in muscle tone There was a slight suggestion of atrophy of the muscles of the dorsum of the right hand There were no gross disturbances of the sensory system The reflexes were equal and active and there were no definite pyramidal tract signs

Skilled Acts—The patient could not write She grasped a pen very clumsily

with either hand and misread simple, large letters She grasped a comb after naming it and rubbed it down her nose with either hand in illustrating its use She became confused at the simplest commands and mixed left and right She misnamed simple objects, calling them by the name of an attribute or a function, *viz*, a "write" for a pen She was distinctly more clumsy in the use of her right hand than of the left She expressed herself fairly well in simple, spontaneous speech There was an element of psychotic negativism in some of the patient's errors and incapacities

Mental Examination—The patient was so extremely childish and confused that any co-operation was handicapped by these factors She was disoriented for time, place, and person and there were very gross memory lapses Her difficulty in expressing herself in part accounts for these, but a small part of her verbatim conversation is quoted to indicate her confusion and her disorientation (What date is it?) "I don't know" (What month is it?) "I don't know" (What year is it?) "I don't know" She giggled (What season is it?) "I don't know" (Is it spring, summer, fall, or winter?) "Well, it's fall No, it's winter" (Is it hot in winter like this?) "Yes, awful hot" (How old are you?) "I'm"—a long pause "I'm Dr Evans' age" (How old is he?) "That's—I'm—let's see—40, I think" (Where is your home?) "I live in that"—a pause "Well, uh—Kansas—Topeka" (How long have you lived there?) "Oh, I don't know" (How long have you been there?) "I don't know" (About how long?) "Oh, I don't know"

While she was under observation for a period of a week she showed no marked emotional instability except in flightiness, a tendency to negativism, and the external manifestation of a frequently recurring shallow emotionless smile The history indicates periods of marked emotional instability

Laboratory Examination—Hemoglobin, 80 per cent, red blood count, 4,390,000, white blood count, 11,800, neutrophils,

tumor In the case cited below there was some slight question as to the possibility of a corpus callosum tumor and for differential diagnostic reasons encephalography was employed

The use of encephalography in establishing the diagnosis of Alzheimer's disease has probably been employed in many instances However, its special study has not been the subject of any of the numerous recent reports of encephalographic investigation While no complete survey of the literature has been made, the more recently reported encephalograph studies do not reveal special mention of the findings in Alzheimer's disease Friedman, *et al* (7) include one case of "degenerative disease of the brain," and Grant (8) includes four cases of "cerebral arteriosclerosis" Harris and Hauser (9) refer to a "degenerative disease of the brain, with marked arteriosclerosis" which they believed was probably a tumor Dixon and Ebaugh (10) refer to a death in an arteriosclerotic patient following the procedure and believe arteriosclerosis to be one of the common contra-indications to its use

CASE REPORT

The patient was a white woman, a farmer's wife, age 56 The chief complaint was confusion beginning about two years ago, with increasing memory disturbances and emotional instability Referred by Dr E A Evans, of Conway Springs, Kansas

Family History—The father died at the age of 53, of asthma, when the patient was 14 The mother died at the age of 82 of cancer of the pylorus, there was no apparent mental disturbance in either one The patient was the eighth of twelve children, the oldest sister died at the age of 67 after having been confined to bed for twelve years with rheumatism and what was regarded as arteriosclerosis The third child in the family had neuritis at the menopause so that "her hands were drawn" The fifth child had diabetes Otherwise the family history seems essentially negative

Developmental History—The patient went through grade school, taught music for a while, and at the age of 17 married her present husband—now in good health She had spent her life on the farm, had been interested in friends, church work, and her children There was a son aged 37, and two daughters aged 34 and 20, all of whom were well The patient had a convulsion when the youngest child was about four days old, but there was no further difficulty of this sort She had had occasional attacks of asthma for the last five or six years, sometimes very severe She had always been a heavy woman, weighing about 200 pounds with a maximum of 250 pounds She ate excessively and abnormally of sweets She had always been constipated and had resorted to a laxative daily for several years She passed the menopause at the age of 50

Present Illness—In 1928, at the age of 50, the patient had influenza, followed by a loss of weight of about 60 pounds over the next six months The family attempted to get her to go to a physician but she steadfastly refused until practically forced to do so At this time a diagnosis of toxic goiter was made, associated with the menopause Following rest in bed in a hospital for two months she seemed to be quite herself

No further difficulty occurred until about the age of 54, when the family noticed that she was becoming forgetful, was not quite so accurate in her work, and began losing things Often she would misplace articles and was concerned about her memory loss Her concern increased to a worry over her financial situation, and then about many things, apparently developing a rather typical picture of mild depression In June, 1933, she fell down the cellar steps, it was not known whether or not she lost consciousness but in any event she escaped with only a bruise on her knee Following this accident, the family noticed that she slipped mentally, becoming confused Her confusion was intermingled with emotional instability, particularly outbursts of temper and ir-

head pain, but vomited only once. She attempted to co-operate through the entire operation and her very mild reaction may in part be explained by her dulled sensorium and the absence of any pre-operative anxiety. She remained drowsy for the following twenty-four hours but gradually gained, and on her discharge six days later seemed brighter and more stable emotionally than prior to the encephalography.

Interpretation of the Roentgenograms Following the Air Insufflation—The two most instructive roentgenograms are here reproduced. In Figure 1, the anteroposterior view, we see a very gross dilatation of both lateral ventricles, the left much more marked than the right. The third ventricle is also visualized clearly, indicating no blocking of the spinal fluid pathway that might have produced internal hydrocephalus. In Figure 2, the lateral view of the encephalogram, we see the smaller right ventricle superimposed over the much more dilated left lateral ventricle, indicating in both of these plates a very marked atrophy of the substance of the cerebral hemispheres, particularly on the left side. There are several areas of air over the cortex though no large accumulations, but sufficient to suggest in addition some cortical atrophy. There is no indication or evidence whatever of any sort of focal lesion and the ventricles are in no wise displaced or distorted. Both of these encephalograms indicate, then, a very marked atrophy of the brain substance, much more marked on the left side, and explaining the more marked neurologic symptoms on the right side.

DISCUSSION

In this case we have an excellent example of the use of encephalography in Alzheimer's disease to conclusively rule out the existence of any tumor which might remotely be thought to be present in view of the neurologic findings. Further,

the encephalography indicates the explanation of the symptoms and supports the repeatedly reported observations of the pathology, namely, the very marked brain atrophy, in this instance more pronounced on the one side than on the other. We believe that in this case the encephalography was a very helpful differential diagnostic aid in conclusively showing the clinical picture to be Alzheimer's disease.

SUMMARY

A case presenting the typical history, physical findings, and mental picture of Alzheimer's disease has been presented, in which encephalography was used helpfully to exclude the remote possibilities of a brain tumor and conclusively to support the diagnosis of Alzheimer's disease. We have found no special study of the use of encephalography in Alzheimer's disease, and feel justified in recommending it.

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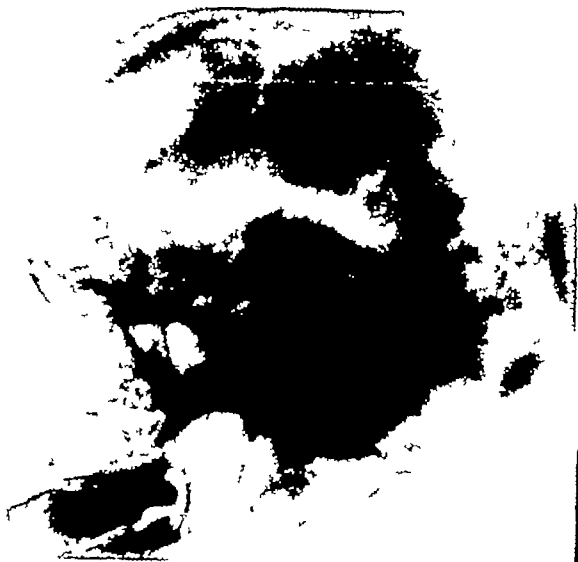


Fig 1 Anteroposterior view See text



Fig 2 Lateral view See text

78 per cent, small lymphocytes, 20 per cent, large lymphocytes, 2 per cent, blood Wassermann and Kahn tests negative Urinalysis acid, specific gravity, 1.031, albumin negative, sugar negative, epithelial cells few, amorphous urate crystals, few A second specimen showed a slight trace of albumin, occasional pus cells, few epithelial cells Spinal fluid cell count 2, protein 55 Wassermann negative in both antigens Colloidal gold curve entirely negative

Encephalography—From the examination data given above the tentative diagnosis of Alzheimer's disease was made, but in view of the fact that there was a marked unilateral apraxia and a suggestion of muscular atrophy along with the aphasia and agraphia and alexia, it seemed advantageous to rule out the remote possibility of a brain tumor An encephalography was recommended and carried out by Dr Leo Stone of our Staff, according to the general plan recommended by Dyke and Davidoff (11) The patient was admitted to the sanitarium twenty-four hours before the encephalography She was given sodium amytal the previous night and 6 grs in the morning, along with a quarter grain of morphine before

coming to the x-ray room where the procedure was carried out The patient cooperated very well Cerebrospinal fluid to the amount of 185 c c was removed and 180 c c of air injected Two test roentgenograms were taken after 30 c c and 120 c c, respectively, of air had been injected The plates here shown were made at the completion of the air injection (Figs 1 and 2)

It was noted that during the course of the removal of spinal fluid, the first 30 to 40 c c flowed very slowly After the first 75 c c the speed of the flow greatly increased and continued throughout the remainder of the procedure The fluid was still flowing freely even when the procedure was stopped at the removal of 185 c c, but because the plates were diagnostic, it was deemed unnecessary to remove more The explanation of this change in rate of flow is not clear One might postulate the possibility that the insufflation of air may have broken some adhesions, and thus permitted a freer flow If such a block in the spinal fluid pathway was the case, one might expect a possible therapeutic benefit from the procedure

The patient reacted very well throughout the procedure, developing a severe

head pain, but vomited only once. She attempted to co-operate through the entire operation and her very mild reaction may in part be explained by her dulled sensorium and the absence of any pre-operative anxiety. She remained drowsy for the following twenty-four hours but gradually gained, and on her discharge six days later seemed brighter and more stable emotionally than prior to the encephalography.

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the encephalography indicates the explanation of the symptoms and supports the repeatedly reported observations of the pathology, namely, the very marked brain atrophy, in this instance more pronounced on the one side than on the other. We believe that in this case the encephalography was a very helpful differential diagnostic aid in conclusively showing the clinical picture to be Alzheimer's disease.

SUMMARY

A case presenting the typical history, physical findings, and mental picture of Alzheimer's disease has been presented, in which encephalography was used helpfully to exclude the remote possibilities of a brain tumor and conclusively to support the diagnosis of Alzheimer's disease. We have found no special study of the use of encephalography in Alzheimer's disease, and feel justified in recommending it.

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CALCIFICATION OF THE ABDOMINAL AORTA¹

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CALCIFICATION of the abdominal aorta is not an uncommon finding in the routine roentgen investigation of the lumbar area. While this condition has not been frequently reported, it is probably more common than is usually supposed. The literature contains but few references regarding the effects produced by this lesion upon the digestive organs. It is, therefore, of sufficient interest to warrant a particular study of this condition. In considering this affection an attempt will be made to correlate the roentgenologic and clinical picture of a group of cases of calcification of the abdominal aorta, emphasizing the gastro-intestinal manifestations.

The significance of calcification of the abdominal aorta and its relationship to digestive disturbances has not been fully recognized. Ridlon and Berkheiser (1) report three cases of calcification of the thoracic and abdominal aorta with backache as a predominant symptom. Gutmann and Routier (2) report 16 cases of abdominal aortitis with gastralgie manifestations, but do not mention whether or not any of their cases revealed the presence of calcification.

The material selected for this study comprises a group of 11 cases of calcification of the abdominal aorta. A study of them points to the fact that degenerative changes in the abdominal aorta may at times play a significant rôle in the production of gastro-intestinal symptoms. Although the number of instances recorded in the literature are but few, nevertheless one must be on the lookout for this condition, especially in those cases with vague digestive disturbances occurring between the fifth and seventh decades of life.

It is of interest to note that in this group of cases the finding of calcification of the abdominal aorta was accidental. Because of the complaint of backache, roentgenograms were made of the lumbar spine, and in these films calcification of the abdominal aorta could be clearly seen. In the antero-posterior view no clue of the condition, as a rule, is disclosed. In the present series of cases only one revealed the presence of calcification of the aorta when viewed from the latter position, this is shown in Figure 3. On the other hand, the lateral view clearly demonstrated the calcification in every instance. It seemed of interest to determine whether in addition to the calcification of the abdominal portion of the aorta, the arch of the aorta was likewise involved in this process. In seven cases upon whom teleoroentgenographic studies were made of the chest, in only one instance was calcification of the aortic arch observed. However, calcareous plaques were noted in the lower thoracic aorta in only four instances. These were observed on the lumbar spine films which included part of the lower thoracic area. A lateral view of the entire thoracic area was made in two instances in this series and no evidence of calcification of the thoracic aorta was observed. The deposition of calcium plaques along the abdominal aorta may involve either a small portion or the entire vessel. Occasionally the calcification may be noted to extend as far down as both iliac vessels.

According to Bordet (3), change in the opacity of the aorta is the earliest sign of aortitis, preceding even subjective symptoms. Many factors predispose to this condition. Arteriosclerosis was the most predominant factor in our series of cases, occurring in all instances. In the majority of these cases there were li¹

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Fig 1 A lateral view of the lumbar area, illustrating calcification of the abdominal aorta



Fig 2 Another case of calcification of the wall of the abdominal aorta is shown in the lateral view



Fig 3 Same case as shown in Figure 2 demonstrating the calcified aorta in the antero-posterior position

of cardiac pathology. It is well recognized, however, that the following conditions which predispose to arteriosclerosis are likewise present in calcification: advanced age, syphilis, alcoholism, gouty diathesis, nicotinism, and diabetes. Syphilis must play but a minor rôle in its production, inasmuch as not a single positive Wassermann reaction was noted in ten cases in which this test was performed. In two instances diabetes was present. Advanced age resulting in senile calcification as a predisposing factor plays an important rôle, since the condition is mostly observed between the fifth and seventh decades.

Physiologic Mechanism in the Production of Gastro-intestinal Symptoms—As the condition affects the wall of the abdominal aorta, transforming a collapsible vessel into a rigid one, certain changes in the circulation of the gastro-intestinal organs must occur which interfere with its normal physiologic function. These changes are instrumental in the production of certain digestive disturbances. Gutmann and Routier (2) consider the digestive varia-

tions as related to the arterial pressure and state: "After meals the arterial pressure undergoes three changes: first, an early increase (immediate hypertension), from 15 to 75 minutes later hypotension, and from two to three hours later another hypertensive phase, which is more intense." Many theories have been suggested to explain the occurrence of pain in abdominal aortic affections. According to Potain (4), Teissier (5), and Carrière (6), this is due to an ischemia of the arteries which provokes gastric intermittent claudication. Pal (7) describes this phenomenon as due to vascular crises, Loeper (8) to a neuritis of the solar plexus.

In this series of cases there were five males and six females, the ages ranging between 50 and 75 years. Table I presents our cases arranged according to sex and age. This table discloses that sex is not a factor in this condition. The ages ranged between the fifth and seventh decades, the majority occurring in the sixth and seventh.

Cardio-vascular Changes—It must be emphasized again that calcification of the

abdominal aorta occurs in the arteriosclerotic period of life. Arteriosclerosis was present in every instance in this series of cases. Cardiac disease was also a prominent factor, as it occurred to some degree in most of our cases. Mobility and palpability of the abdominal aorta were not detected except in one instance in which pulsations were distinctly palpable. According to Gutmann and Routier (2), auscultation over the abdominal aorta may reveal a systolic murmur quite different from the systolic sound normally perceived, and they attach considerable importance to this sign in abdominal aortitis. Changes in the femoral pulse were not especially noted in our cases, but Gutmann and Routier record some changes in the femoral pulse in aortitis due to changes in the wall of the vessel, resulting in a more rapid flow. Abnormal circulatory manifestations in the abdominal organs must occur as a result of this condition, due to loss of expansibility and contractility of the wall of the aorta. The blood pressure in this group of cases varied considerably.

The rôle which calcification of the abdominal aorta plays in disturbance of the digestive tract is a variable one, inasmuch as there is not always convincing evidence at hand to demonstrate that the change in the aorta is the primary etiologic factor in the production of symptoms. A true clinical picture of the condition is not readily discernible, the symptoms often being of a vague character. There are no characteristic symptoms or group of symptoms which are diagnostic of the condition. Although the diagnosis of calcification of the abdominal aorta is quite simple by means of the roentgen-ray study, its interpretation as a causative factor of gastrointestinal disturbances is by no means as clear. There can be no question, however, but that this condition may be responsible for many abdominal disturbances, and increasing importance must be attached to this finding when no other organic lesion can be detected to account for the digestive symptoms. An example of a case is presented to illustrate the gastro-

intestinal manifestations encountered in this affection.

R. L., aged 58, female, first visited the Sinai Hospital eleven years ago, with the complaint of indigestion. The symptoms were those of fullness, distention, belching, sour regurgitation, constipation, and vertigo. One year later, she developed a constant epigastric pain, which increased following meals. In addition to the pain, the other symptoms described above continued without relief. A gastro-intestinal roentgen investigation proved negative. An Ewald test meal revealed a normal gastric content (free acid 20, total acid 40). Her blood pressure at this time was 128/66. A year later she began to complain of severe backache, which was especially pronounced on movement. Another Ewald test meal, examined two years later, still revealed a normal gastric content (free acid 19, total acid 46). Her backache and digestive symptoms persisted up to this year (1933), when an x-ray examination of the lumbar area revealed the presence of marked calcification of the abdominal aorta. This examination also presented evidence of slight hypertrophic changes of the lumbar vertebrae. It must be pointed out that it is most difficult to establish the fact that these symptoms are due to calcification of the abdominal aorta, but since no other gastro-intestinal lesion could be found to produce these symptoms, it is reasonable to consider the possibility of calcification as a possible etiologic factor.

In a survey of this series of 11 cases, the gastro-intestinal manifestations were of striking interest. In three instances the digestive symptoms were of minor import, the symptoms varying from mild to severe. Pain in the abdomen and back was the most prominent symptom, and was often of an encircling, girdle, or constricting type, radiating from the abdomen to the back and reversely, frequently becoming localized in the epigastrium. Moderate or severe pain occurred in six instances of this series, while in five there was some abdominal distress but no actual pain.

On the other hand, abdominal soreness and tenderness occurred in seven cases Gutmann and Routier observed that an early discomfort consisting of a sensation of heaviness and tension, with pain coming on three or four hours later, prevailed in his study of the digestive symptoms In this series of cases the symptoms in some instances resembled those of ulceration, which were relieved temporarily by soda However, the usual relation of food and the periodicity of the symptoms was not observed Vomiting occurred in three instances, but in none was there any hemorrhage Constipation was found in eight cases In one, diarrhea was a prominent symptom and in two the bowel functioned normally The appetite remained good in seven cases, while in four it was poor In three instances acid regurgitation was observed and in six abdominal fullness and distention were noted Loss of weight occurred in all instances of this series Backache was likewise a common complaint The physical examination revealed a generalized arteriosclerosis, with varying degrees of cardiac involvement The abdomen presented evidences of tenderness and soreness on pressure In thin individuals, the hard tubular aorta may be palpated and pulsations felt Hemorrhoids were observed in three of our cases

Roentgen Examination—Gastro-intestinal roentgen examinations were performed in five cases of this series, of which three were found to be entirely normal In one, a penetrating gastric ulcer was observed and in another a moderate duodenal stasis It is of interest to note that in two cases in which the roentgen examination revealed a normal stomach, ulcer symptoms were quite prominent In one case, carcinoma of the transverse colon was found, confirmed by operation The roentgen ray also revealed evidence of enlargement of the heart in three instances and dilatation of the aorta in three cases

During the routine roentgen examination of the lumbar area, it is especially important to include a lateral view In this position evidence of calcification of the abdominal aorta may be best visualized The anteroposterior position obscures the aorta in most instances due to overshadowing of the vertebræ, on the other hand, the anteroposterior view will often reveal the presence of calcification of the iliac vessels The roentgen diagnosis is made by the presence of calcareous plaques along the course of the abdominal aorta, as it descends along the vertebral column, anterior to the bodies of the lumbar spine The plaques are of different lengths and thicknesses, of flaky appearance, and are irregularly placed along the margins of the

TABLE I—IMPORTANT GASTRO-INTESTINAL FINDINGS OF 11 CASES OF CALCIFICATION OF THE ABDOMINAL AORTA

Case	Sex	Age	Pain	Abdominal Tenderness	Vomiting	Fullness and Distention	Appetite	Sour Regurgitation	Constipation	Diarrhea	Associated Gastro-intestinal Conditions	Backache	Loss of Weight	Hemorrhoids
1	M	50	+	+	+	+	+	+	0	+	Ulcer Gallstones	+	+	0
2	M	60	0	+	0	+	+	0	0	0		+	+	0
3	F	64	+	+	0	0	+	0	0	0		+	+	0
4	F	58	+	+	0	+	0	+	+	0		+	+	0
5	F	70	+	0	0	+	0	+	+	0	Duodenal Stasis	+	+	0
6	F	73	0	+	0	+	+	0	+	0		+	+	0
7	M	75	0	0	0	0	+	0	+	0		+	+	0
8	F	55	+	+	+	0	0	0	+	0		+	+	+
9	M	68	0	0	0	0	+	0	+	0	Carcinoma Colon, Gallstones	+	+	+
10	M	55	0	0	0	0	0	0	+	0		+	+	+
11	F	65	+	+	+	+	+	0	+	+		+	+	0

aorta The caliber of the aorta becomes quite visible

Hypertrophic changes in the lumbar vertebrae of varying degrees were observed in six instances of our series

SUMMARY

In all obscure cases of abdominal discomfort and backache, with vague gastrointestinal symptoms which occur between the fifth and seventh decades, the possibility of the presence of changes in the abdominal aorta should be carefully investigated. Calcification of the abdominal aorta is of sufficient clinical importance to be considered as not only an etiologic factor in the production of lumbar pain, but also as a factor in the etiology of digestive symptoms. The roentgen-ray examination of the lumbar area offers the best

means of investigation in the diagnosis of calcification of the abdominal aorta

Many thanks are due to Dr Alfred Ullman, who kindly permitted me to use this material. To Dr Julius Friedenwald, I am deeply grateful for his many suggestions in the preparation of this paper

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AN ILLUSTRATIVE CASE OF SYRINGOMYELIA TREATED WITH ROENTGEN RAYS

WITH GENERAL DISCUSSION OF THE EFFECT OF RADIATION UPON THIS DISEASE¹

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THE use of radiation in the treatment of various neurologic conditions has proved to be a valuable therapeutic agent, but the most strikingly favorable results apparently occur in syringomyelia. Within the past decade this mode of treatment has become the choice therapeutic procedure of this distressing disease. Syringomyelia is particularly suitable for roentgen therapy because the pathologic structure of this disease is highly responsive to the action of the rays (1).

PATHOLOGY

The pathologic picture is essentially one of gliosis followed by the formation of a cavity or cavities in the substance of the cord. The glial tissue surrounding the cavity varies in thickness not only in different cases but also at different levels of the same case. The mode of production is not very definite, but the prevailing theory is that the pathologic process is essentially of neuroglial tissue. In short, it is a slowly growing or proliferating process of glia cells and fibers. This is followed by softening of the overgrown newly formed tissue, which consists of fibrils with a few nuclei. The tissue soon begins to stain badly, particularly around the few blood vessels which it contains, and is transformed into a homogeneous rarefied structure. Crevices appear within the area which gradually form into cavities. The cause of this central gliosis is not known, some believe that it is due to a developmental defect or to the persistence of embryonal tissue which later acquires the power of pathologic growth.

From the standpoint of radiotherapy all productive or proliferating tissues, whether inflammatory or not, are radiosensitive (2 and 3). The effectiveness of radiation in syringomyelia is brought about by the destructive action of the rays upon the growing glious tissue. However, in order to obtain the best results it is necessary that the patient should receive the treatment sufficiently early in the course of the disease, before the destructive process has set in, namely, before cavity formation takes place.

This brings us to the question of regeneration of nervous tissue. In discussing this subject we must forbear the claim that radiation can regenerate or reconstruct nerve tissue, despite the fact that this often militates to some extent against the use of roentgen therapy of this disease. Those who oppose radiation in syringomyelia claim that, whereas it is admitted that the condition is a destructive process and that the rays have no power to regenerate nerve tissue, it seems absurd to claim that the use of x-rays can bring about a cure or relief in this affection. Our answer to their objection is simple. As stated above, we still refuse to claim that roentgen rays can reconstruct or regenerate nerve tissue. Nor do we claim that we can always completely cure a case of syringomyelia without residual sequelæ.

Radiation, however, can halt the inflammatory process of nerve cells and fibers in the same manner that it does in any other inflammation. This may bring about a partial or even complete recovery, depending upon the severity of the inflammation as well as upon the extent of the destructive damage which has already

¹ Read before the Clinical Society, Hospital for Joint Diseases March 6, 1934

aorta The caliber of the aorta becomes quite visible

Hypertrophic changes in the lumbar vertebrae of varying degrees were observed in six instances of our series

SUMMARY

In all obscure cases of abdominal discomfort and backache, with vague gastrointestinal symptoms which occur between the fifth and seventh decades, the possibility of the presence of changes in the abdominal aorta should be carefully investigated. Calcification of the abdominal aorta is of sufficient clinical importance to be considered as not only an etiologic factor in the production of lumbar pain, but also as a factor in the etiology of digestive symptoms. The roentgen-ray examination of the lumbar area offers the best

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favorable effect can hardly be expected from further irradiation. The amelioration of these subjective symptoms were, therefore, highly satisfying in this case because they indirectly indicated a favorable prognosis.

(2) The segmental pain and temperature fibers are generally the first to be affected, and as a rule there is an early loss of sensitivity to pain and temperature sensation. In this case these sensory disturbances appeared later than all other symptoms of syringomyelia, thus making the diagnosis difficult, which incidentally delayed radiation treatment.

(3) Another striking feature of the case was the extraordinary slow progress of the disease. It took two years before some pathognomonic signs and symptoms of syringomyelia came to the front.

(4) Irradiation will restore the pain and temperature sensibility in all cases except when the duration of the disease was unduly prolonged before the treatment was commenced. Nevertheless this does not always apply to disturbances in temperature sensation. They sometimes will persist even after two or more series of treatments have been administered.

Referring to the illustrative case of this paper, we find that after six treatments the patient began to improve. His sensory disturbances, as far as the pain fibers were concerned, were much better and their function was gradually completely restored. This was not the case with the temperature fibers, their restoration was delayed and despite the fact that almost all other signs and symptoms have disappeared, except a slight disability of his right hand and fingers (which does not at all interfere with his work), we cannot claim complete restoration of the temperature sensibility.

Giese and Ossinskaja (5) report eight patients out of a group of 128 in whom the temperature sensibility remained disturbed after pain sensibility had otherwise become normal. Other observers also claim that pain sensations are more com-

pletely and readily restored than the temperature sensibility (6).

(5) From the standpoint of clinical material and clinical demonstration, this case was ideal. His hands were full of cuts, bruises, burns, and scars. These injuries were sustained because he was unaware of the loss of sensation, and therefore scalded or injured his hands without knowing it. The sensory dissociation made its advent insidiously, it being unnoticed by the patient until one day while bathing he discovered that he could detect cold and heat upon some parts of the skin and not on others.

(6) Muscular atrophy is a common clinical feature of this disease. It is entirely dependent upon the amount of pathologic changes that are present in the gray matter. There is a difference of opinion as to the ultimate effect radiation therapy has on muscle, tendon, and cutaneous reflexes. Many believe that radiation has little or no effect, on the other hand, some authors frequently report complete restoration of some reflexes particularly the tendon reflexes of the upper extremities.

Muscle function generally improves and becomes normal in 50 per cent of the cases. Paresis and paralysis of various muscles of the upper extremities are more frequently improved after irradiation than those of the lower extremities. We also obtain similar results in gait, ataxia, and muscle strength. Above all, the bulbar symptoms improve to a relatively greater degree than the motor disturbances of the lower and upper extremities. In our case under discussion, muscular atrophy of both hands and forearms were equally affected, but the muscles of the back were normal. After six treatments the patient was able to return to work. The tremor of the hands gradually improved and the contractures resulting from muscular atrophy became normal (6 and 7).

There are no routine iron-clad rules for the technic of radiation therapy in syringomyelia, as there are none for other conditions. Each case presents different and

been done to the spinal cord before irradiation had been instituted. Furthermore, if the condition has already reached the destructive stage, radiation can also interfere with the process, and in this way it is possible to preserve the residual function of the cord which has been retained in the tissue. Before presenting the case let us briefly review the clinical side of this disease.

Syringomyelia can be recognized by the following three groups of symptoms:

(1) A progressive muscular atrophy of the upper extremities with fibrillary twitchings.

(2) Sensory disturbances which take the form of syringomyelic dissociation or posterior-horn type dissociation of sensibility.

(3) Trophic and vasomotor disturbances which include paronychia, anomalies of sweat secretions, osteo-arthropathies, fissures, ulcers, and gangrene. (4)

REPORT OF CASE

The patient was first seen in August, 1932, at which time he presented a history of six months' duration. He had had a cold and soon after felt a weakness in both hands, being unable to cut bread or button his clothing. This weakness continued for several months, and then improved slightly. He worked as a counterman in a restaurant, was never exposed to metal poisoning, had no history of alcohol or syphilis, and did not complain of paresthesias.

At his first examination his hands showed a symmetrical atrophy of the thenar and hypothenar eminences, and of the space between the first and second metacarpal bones. Also, there was a partial flexion contracture of all the interphalangeal joints which gave a claw-like appearance to the hands. There was atrophy of all interossei. A bilateral coarse tremor and marked weakness of both hands were present. A slight thickening of the subcutaneous tissue of the hands was present, but there was no wrist drop. Reflexes

could not be elicited at all in the upper extremities. Knee-jerks were equal and somewhat hyperactive. Sensation to pinprick was at first unimpaired. He had a slight difficulty in speech, and some tremor of the tongue. Sensory impairment could not be elicited early in the disease, but later, on April 15, 1933, areas of analgesia and thermoanesthesia were found in the upper extremities, the higher segments of the trunk, as well as the neck and shoulders. The diagnosis of syringomyelia was made.

The case was referred to our department for radiotherapy. Roentgentherapy was administered at weekly intervals. The factors of radiation were as follows: 150 K V, 5 ma, filtration, 4 Al, focal distance, 40 centimeters. One-third of an erythema dose was given weekly for each area. The field for irradiation consisted of the entire cervical and upper dorsal spine.

After six weeks, sensory disturbances were ameliorated. Impaired muscular function and tone were markedly improved after six treatments, but muscle atrophies in the upper extremities were not improved as far as the apparent volume of muscle was concerned. He practically lost his tremor and was able to resume work. The color of the skin of his hands, which had been reddish, became almost normal. In short, both objective and subjective symptoms improved, and while his pain conduction fibers are evidently normal, he still has some impairment in the conduction of the temperature fibers.

THE EFFECT OF RADIATION IN SYRINGOMYELIA

This case presented the following interesting clinical and radiologic features:

(1) It is commonly known to radiologists that subjective complaints of coldness, numbness, and tingling sensations will usually disappear in a short time under the influence of roentgen rays. When no definite improvement takes place by the end of the first series of treatments, a

tion as well as upon the extent of the destructive damage which has already been done to the spinal cord before irradiation had been instituted ²

In the case under discussion, no final diagnosis was made until eight months had passed after the patient presented himself to our clinic for the first time. Before he came to us, he had been under observation in other institutions of this city. In none of them was a definite diagnosis made of his condition. Syringomyelia was suggested by some of the neurologists but this diagnosis had to be excluded because of the inability to establish sensory dissociation. However, something occurred in his condition which changed the entire aspect of the case. On April 15, 1933, which was approximately two years after the initial symptoms of his affection and eight months after he became a patient of our clinic, he clearly and unquestionably showed definite analgesia and thermo-anesthesia, which once and for all confirmed syringomyelic dissociation (8 and 9).

The author therefore is of the opinion that this case ran a parallel course with the one reported by Head and Thompson. In both cases the diagnosis was difficult because of the absence of analgesia, and in both, analgesia did not come to the front until some change occurred in the physical condition of the patient, which interfered

with the diagnosis of syringomyelia. In their case it was a co-existent arthropathy, in our case an undetermined condition that hindered the elicitation of sensory dissociation.

There are many causes for the delay of the appearance of sensory disturbances. For instance, the distribution of thermo-anesthesia and analgesia is often found to be irregular. If the progress of the disease is slow, we may find sensory loss in one hand which may be limited above a line encircling the forearm. In the same way, an area including the nose, mouth, and eyes may preserve its sensibility intact, while the surrounding regions are completely insensitive to pain and temperature. Quite often we come across one patch of analgesia and thermo-anesthesia which is separated for a time from another by a healthy area, and coalescence occurring later on. Such and similar conditions, which happen quite frequently (10), are apt to mislead the examiner and throw him off the proper track.

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² In explanation of the late appearance of sensory disturbances of this patient, the author is of the opinion that this case was similar to the one reported by Head and Thompson. In that case complete cutaneous analgesia was co-existent with deep hyperalgesia of a painful arthropathy. The lightest pressure produced pain, yet superficial layers of the skin were analgesic to the prick of a pin when raised from the subcutaneous structures.

peculiar pathologic and clinical characteristics which must be met individually by the radiotherapist. It is, therefore, improper to say that cases of syringomyelia should obtain radiation to the cervical and upper dorsal region of the spine as a routine measure, the better procedure is to localize each lesion of the spinal cord. This largely determines the degree and extent of the inflammatory or destructive process that may be present. In this disease, localization is a great help to the radiologist because it indirectly maps out the proper fields to be irradiated and aids in centering the tube for each area to be treated. If the radiologist has insufficient training in the localization of spinal lesions, it is his duty to call in a neurologist for the purpose of interpreting the topographical relations of the vertebræ to the segment of the spinal cord.

Our knowledge of motor, sensory, reflex, and visceral representations in the single segments of the cord is fairly adequate today to enable us to localize circumscribed lesions that involve the white and gray matter at a definite level. In most of the cases of syringomyelia the sensory disturbances, *viz*, loss of pain and temperature sensibility, are segmental in distribution. They are caused by inflammation or destruction of the posterior horns of the gray matter of one or several segments.

Let us suppose that we find areas of analgesia and thermo-anesthesia in the upper extremities, the higher segments of the trunk, as well as of the neck and shoulders. This distribution of the insensitive areas shows the type of cases most frequently met with in the larger clinics of New York City. It definitely points to involvement of the cervical and upper dorsal regions of the spinal cord. The author's technic in such cases is as follows:

The field of radiation should include the entire cervical spine, also the dorsal spine as far down as the seventh dorsal vertebra. The size of each field to be 8×10 cm, arranged lengthwise close to each other. The factors are 180 K V, 4 ma, filtration, 0.5 Zn plus 3 Al, focal distance, 40 centi-

meters. Each field should obtain one-third of an erythema dose at one sitting. The treatment should be administered every other day until each field has obtained 100 per cent of a skin erythema dose. This is followed by an intermission of six weeks, when another series may again be administered in the same manner described above. A third and fourth series may be repeated if necessary after a further intermission of eight weeks between each series.

SYRINGOBULBIA

Cases which are not quite as frequently met with as the ordinary cases of syringomyelia are those that affect the brain stem. This condition is generally known as syringobulbia. The disease affects primarily the medulla and may involve the motor nuclei of the cranial nerves. Very often syringomyelia and syringobulbia are associated. The manifestations of bulbar disease may precede those of spinal involvement, or *vice versa*. Whether the disease ascends from the cord to the brain stem or descends from the brain stem to the cord is a mooted question. These cases present fibrillations, atrophy, and paresis of the tongue. The palate, uvula, and vocal cords may show similar signs. The sensory disturbances in these patients are found in the region of the trigeminus. Perception of pain and temperature is lost, while other sensations are as a rule unimpaired. In short, the lesions of this condition are primarily in the brain stem, but they are also as frequently present in the cervical spine.

The treatment plan for radiation in cases of syringobulbia is similar in principle and method in every respect to the procedure described for syringomyelia, except that one occipital field and two lateral fields of the head (one on the right and one on the left side over the base of the brain) are irradiated in addition to the fields of the cervical and upper dorsal spine.

In short, radiation can bring about a partial or even a complete recovery depending upon the severity of the inflamma-

usual collodion, graphite-coated thimble chamber, which is suitable for use with harder radiation, with a special silk-mesh

length theoretically obtainable at this voltage was in the neighborhood of 0.3355 \AA as calculated from the fundamental

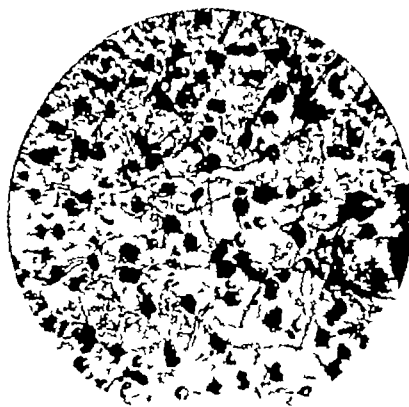


Fig 1 A



Fig 1-B

chamber devised by Dr Failla, and most kindly lent to us by him, in which the wall and absorption effects of longer radiation are very largely eliminated. It was, therefore, unnecessary to introduce corrections for these factors which should certainly have been introduced with most other types of chambers. The distance factor was extrapolated to the position of the pollen grains and mold spores in accordance with the inverse square law. The procedure was not strictly correct in this case, since with this tube the radiation did not emanate strictly from a point source, but the accuracy of the procedure was well within the limit set by the experimental material itself. The milliamperage factor was also extrapolated to that used, the curve in this case being very nearly reliable. The incident energy input of the tube under experimental conditions, at the point of exposure of the material, was found to be 2.1×10^4 roentgens per minute.

In quality, the x-ray beam from this tube was very nearly monochromatic, by far the greater portion of radiation lying in the regions of the $K\alpha$ and $K\beta$ lines for copper, respectively 1.537 and 1.389 \AA Angstroms. The shortest wave

quantum relation $Ve = h\nu_{\max}$ as applied by Duane and Hunt²

The source of hard radiation used was a standard Victor deep therapy outfit, comprising a high tension transformer with cross-arm mechanical rectifier of the Snook type as the high voltage generator, and a standard Coolidge water-cooled tungsten-target tube, of the thick-walled type. The tube was operated at 200 KVP and 30 ma , the pollen and mold being exposed at a focal distance of 11.4 centimeters. The incident energy input of the tube was measured at the point of exposure of the material with the Failla instrument, the collodion-graphite chamber, which at this voltage exhibits negligible absorption and wall effects, being used. It was necessary to reduce the tube current to 1.5 ma and to extrapolate to the higher value in order to bring the energy reading within the range of the instrument. The input was found to be 3.0×10^3 roentgens per minute under the conditions of experiment.

The shortest wave length theoretically obtainable at this voltage was 0.062 \AA . No metal filter was used, but the glass of the wall interposed a filtering action

² Phys Rev, 1915 6, 166

THE INHIBITION OF GROWTH IN POLLEN AND MOLD UNDER X-RAY AND CATHODE RAY EXPOSURE¹

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It was the purpose of the following investigation to determine, within fairly wide limits, the point at which mature pollen grains, cultured *in vitro*, and mature spores of *Penicillium* become inactivated on exposure to x-rays and high voltage cathode rays. Such a piece of work seemed of interest and desirable for several reasons. So far as known by the authors, no systematic previous work has been undertaken in the x-raying or cathode raying of mature pollen with a view of determining its rate of "dying" and its point of inactivation. Considerable work has been done in the x-raying of mature pollen in the hope of producing mutations, and, while such work does not show promise of yielding nearly as fertile results in the form of genetic aberrations as may be obtained by the irradiation of pollen mother cells previous to the first reduction division, it is of interest that rough working data of permissible limits of exposure under given conditions should be at hand. Again, so far as known by the authors, no comparative work has been done on the resistance of pollen grains and mold spores to x-rays and cathode rays under the same conditions. Such a comparison should be of interest in view of the work which has been done in the x-raying and cathode raying of molds. It seemed worth while to investigate pollen as a biologic material of possible use in quantitative studies of radiation effects. And finally, little work appears to have been done, even with the molds, in the comparative investigation of the energy inputs of different forms of energy at roughly equivalent points of inhibition.

Material Used—After considerable preliminary work involving a large range of plant material, it was decided to confine

the experiments with pollen to that of plants of the family *Liliaceæ*, and to work principally with *Lilium longiflorum* because of its availability at all times and the ready germinability of its pollen under a fairly wide range of conditions. Several other species were included in the investigation, however, and found to be essentially similar in behavior. Chief among these were *Lilium speciosum*, *L. regale*, *L. henryi*, and *L. auratum*. Some work was also done with *L. philadelphicum*, *L. canadense*, *L. sulfurum*, and even the triploid day lily *Hemorocallis fulva*, but these species proved less satisfactory and were abandoned.

Spores of a culture of the green-spored mold genus *Penicillium* were used, and proved so ready of culture and so thoroughly satisfactory in germination throughout that it was unnecessary to consider any further material.

Sources and Character of Radiation—Two sources of x-rays and one of cathode rays were used in this work, so selected that comparisons of inactivation might be made under fairly widely variant conditions.

As a source of soft x-radiation, a line-focus tube with copper target was used, connected to the pumps, and operated from a high tension transformer. It was completely self-rectifying when operated, as it was throughout the work, at 37 K V rms and 20 ma of current. It was provided with an aluminum window of 0.025 mm thickness.

The pollen and mold were treated at a focal distance of 51 centimeters. The tube output was measured at a focal distance of 41.9 cm, and a current of 10 ma with a standard Failla radium-compensated measuring instrument. The device, however, was equipped in place of the

¹ Received for publication Oct. 13, 1934.

the temperature gradually falling through a small range. The rise of nitrobenzene in the capillary was a marked one, amounting often to five or more thermometric scale divisions.

Once the incident energy of the cathode beam had been determined in calories per unit area it was readily convertible to roentgens, using Gaertner's⁹ value for the ionization potential of air in electron volts and an electron volt-calorie equivalence factor derived from Crowther's¹⁰ factor for the erg in electron volts. Such a procedure does not give the correct order of magnitude of the ratio of energy inputs of the two sources, however, since the copper calorimeter, by virtue of the fact that it absorbs an extremely high percentage of all incident electrons, is in reality measuring the energy derived from a cathode beam of given cross-section and infinite extent, while the ionization chamber measures the energy similarly derived from an x-ray beam of given cross-section, but, by definition of the roentgen, also of finite length (1 centimeter). We may roughly correct for this situation in this fashion. Let us calculate the voltage drop of a single electron at the calorimeter face in traversing a one-centimeter layer of air and determine what percentage it is of the total drop. Then, since the calorimeter completely stops every electron striking its face (an assumption justified for this work), the true value of the energy of the cathode beam in terms of roentgens will be its measured energy, converted to roentgens on the basis of the derived calorie-roentgen equivalence factor already determined, multiplied by this factor—a procedure which also involves the assumption that electron velocity in a cross-sectional area of this cathode beam is uniform. Using the J. J. Thompson formula¹¹ for the voltage drop of a single

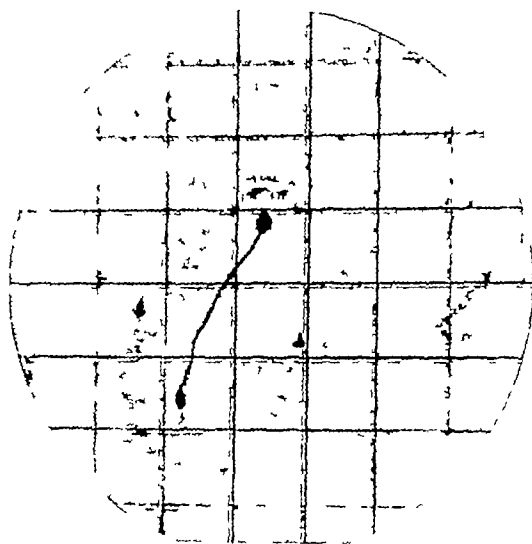


Fig 3

electron

$$V_0^2 - V_x^2 = Kdr$$

when K = electron mass abs coefficient
 d = density of matter traversed
 r = thickness of layer traversed

the electron velocity at the outer face of the calorimeter was calculated at each experimental point, the first portion of the calculation accounting for the tube window, the second for the air layer. The voltage drop for an electron at this velocity through one centimeter of air was next determined. The ratio of this drop to the total was calculated and applied to the energy derived at each distance on the conversion basis. Proceeding in this fashion, determinations were made at distances from the tube window of 1, 2, 2½, and 3 inches, the output being found to be, respectively, 9.0×10^4 , 4.0×10^4 , 1.6×10^4 , and 1.1×10^4 roentgens per second. These values are probably low, due to the fact that the assumptions mentioned are not strictly valid.

The accuracy of the calibration procedure used with cathode rays is probably the lowest of the three sources. Errors of reading in the calorimeter and errors introduced by changing conditions within the copper cell itself, though minimized

⁹ Gaertner, O. Ann d Physik., June 7, 1929 2, 94-122

¹⁰ Crowther J. A. British Jour Rad 1929 2, 175-187

Bord, W. N. Phil Mag 1926, 6, 401-422

¹¹ Conduction of Electricity through Gases p 378

equivalent to about 0.10 mm of copper. At 0.70 Å the intensity of the emergent radiation was only about 0.3 per cent

tube, as described by Coolidge and Moore,⁵ Taylor,⁶ Lenard,⁷ and others. The method which proved most convenient in the



Fig 2-A

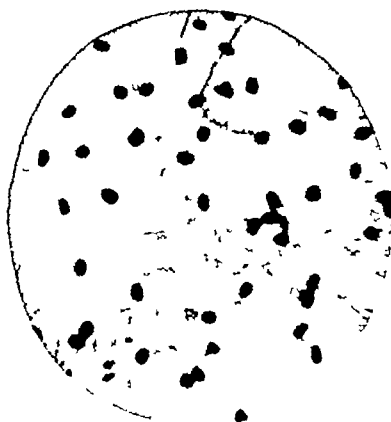


Fig 2-B

of that impinging on the inner wall surface, as calculated from Compton's 1926 value for the mass absorption coefficient of Cu,³ and this may be considered the cut-off point. Substantially all of the primary radiation incident was included within these limits. The greatest intensity of radiation lay within the K_{α} and K_{β} doublet region for W, between 0.21 and 0.18 Å. The second and third order lines were present, though of greatly diminished intensity, but general radiation at this voltage is very considerable.

A Coolidge single-stage high voltage cathode ray tube, equipped with "Resistol"⁴ window, of 0.6 mil thickness, connected to the pumps, and operated at 250 K V P and 1.5 ma was the source of cathode rays. Since the window was air-cooled, it proved more convenient to vary the distance of the experimental material from the tube, the time of exposure being maintained at one second. The material was treated at window distances of 1, 1 $\frac{1}{4}$, 1 $\frac{1}{2}$, 1 $\frac{3}{4}$, 2, 2 $\frac{1}{4}$, 2 $\frac{1}{2}$, 2 $\frac{3}{4}$, and 3 inches.

Several methods may be adopted for the calibration of a high voltage cathode ray

present case was a thermal calibration devised by Daniels and Bussey,⁸ which presents the advantage that, in cases such as ours in which the tube window must remain electrically floating, no grounding connection of the reading instrument is necessary. A measurement of the heating effect of the electron stream in calories was made with a copper calorimeter of 7.5 cm diameter and 0.3 cm thickness, built as a thin drum from two soldered spinings. The vessel was equipped with a fine glass capillary and filled with nitrobenzene, which acted at once as the heat-absorbing medium and the temperature indicator. The capillary was fitted with a scale, and readings of the meniscus rise made with a telescope mounted at a safe distance. Immediately after the completion of readings, which consisted usually of ten trials, the calorimeter was calibrated in water, the volume of water remaining constant (to avoid a change of pressure on the calorimeter walls, the device being surprisingly sensitive) and

⁵ Coolidge W D and Moore C N G E Rev August 1932 35, 413-417

⁶ Taylor L RADIOLOGY 1931 17, 796

Lenard, P Quantitativen über Kathodestrahlen aller Geschwindigkeiten 1925

⁸ Bussey, W F, and Daniels F Jour Am Chem Soc December 1928, 50, 3271-3286

³ Compton, X-rays and Electrons D Van Norstrand Co 1926

⁴ A chrome nickel steel

spores were pressed from sporangia borne by mycelia usually less than forty-eight hours old onto clean 7.5×2.5 cm glass slides. The slides were irradiated, and the spores clinging to them were then sown dry upon sterile cultures of prune agar. They were then cultured in moist sterile chambers at 30°C for from twenty-four to thirty hours. In the case of high voltage x-rays, spores were sown on agar on 2.5×2.5 cm glass squares before irradiation. The elevated and constant temperature so accelerated development as to prove desirable. Dry sowings gave satisfactory results, and it was found better in the present case to examine the spores directly with the microscope in counting. Both spores and pollen grains were occasionally stained with I to facilitate counts. A record of count of 40,000 spores was made.

The methods of exposure to radiation were essentially the same for pollen and molds. In the case of the high voltage x-ray tube and the cathode-ray tube, the area exposed was many times that occupied by the sample, so that moderate evenness of radiation intensity throughout the sample was assured. With the low voltage tube, however, the irradiated area was of the same order of magnitude as that occupied by the sample. The position of the sample was carefully checked with a fluorescent screen in this case, and an additional check was afforded by the blackening of the glass over the exposed area, forming a sharply defined spot. In the case of the low voltage x-ray and the cathode-ray tubes the samples were exposed directly to the beams. The longer times required for inhibition with the high voltage source necessitated that the slides be enclosed in glass Petri dishes to prevent their drying. The measurement of incident energy in the latter case was made under a Petri dish cover, thus including such absorption and scattering as might take place there.

RESULTS

The results of each experiment were

expressed in terms of the survival ratio as defined by Wyckoff,¹⁶ the ratio of the percentage of grain or spores showing development to those showing similar development in the controls. A control culture was made for each series of runs. A large number of preliminary runs was made, followed by a relatively small number of final tests, when the approximate "lethal limit" was established and the technic of irradiation and culture properly developed.

SOFT X-RAYS

I *Molds*—Four series of final experiments, involving 7,800 spores, were made with mold, yielding the following results

TABLE I

Test	2 min	4 min	6 min	8 min	10 min	12 min	14 min
1	0 80	0 40	0 16	0 16	0 12	0 05	0 04
2	0 80	0 57	0 38	0 24	0 05	0 01	0 04
3	0 86	0 54	0 19	0 21	0 11	0 05	0 06
4	0 93	0 37	0 18	0 26	0 15	0 01	0 03
Average	0 85	0 47	0 23	0 22	0 11	0 03	0 04

II *Pollen*—Five series of final experiments, involving 2,040 counted pollen grains, were made with soft x-rays, at exposures of 4, 6, 8, 10, 12, and 14 minutes, as shown in Table II

TABLE II

Test	4 min	6 min	8 min	10 min	12 min	14 min
1	0 78	0 91	0 27	0 41	0 15	0 00
2	1 40	0 52	0 52	0 00	0 05	0 00
3	0 29	0 12	0 00	0 14	0 22	0 00
4	0 41	1 50	1 10	0 78	0 41	0 00
5	2 80	1 80	1 90	1 50	0 67	0 17
Average	1 10	0 97	0 74	0 57	0 30	0 03

HARD X-RAYS

Molds—Five series of final tests were made with hard x-rays, the number of counted spores being 13,000. Exposures were made with a time increment of ten minutes. The energy increment was thus 3.0×10^4 roentgens, as against an increment of 4.2×10^4 roentgens at two-minute intervals with soft radiation. The rate of inactivation, however, proved much slower, so that exposures of 20, 30, 40,

¹⁶ Wyckoff R W G Jour Exp Med Nov 1, 1930, 52, 769-780

by averaging a number of readings, were undoubtedly present, and cathode-ray scattering was unquestionably a vitiating factor. The measurements, however, are considered to be within the accuracy required for present purposes.

CULTURE AND EXPOSURE OF POLLEN AND MOLD

The method of pollen culture was essentially that of Jost,¹² which has since been used with good success by a large number of other workers. Agar cultures of 2 per cent concentration by weight were made up with distilled water. In preliminary work, samples containing 5, 10, and 15 per cent by weight of cane sugar were used, but it was found desirable to eliminate this variable, and only 5 per cent cultures were used in the final work. Drops of culture medium were flowed onto 75 × 25 cm plain slides, or, in some cases, onto 25 × 25 cm glass squares, and allowed to set. The pollen was sowed immediately before exposure to radiation. In one series of runs the agar was coated with a "sterile yeast" solution, prepared according to the directions of Brink¹³ and carefully dried before inoculation of pollen. This was found, in conformity to Brink's work, to bring about a longer tube development and a higher total germination percentage, as indicated in the accompanying figures, but did not markedly affect the shape of the survival curve.

A simple and rather thoroughly satisfactory method was developed for the sowing of the pollen, which eliminated, on the one hand, the clumping which results from dry sowing and which, because of the limited penetration of cathode rays, should be avoided, and on the other the limited and thoroughly erratic germination which frequently results from sowing on the surface of an evaporable liquid. A small clump of pollen was allowed to spread on a drop of water placed on the

agar until a uniform, nearly equidistant, spacing of the grains was obtained. The water drop was then removed with filter paper and the slide quickly inverted in a desiccator over CaCl₂ and allowed to remain in this position until the agar was sufficiently hard so that each grain did not sink into a pit. The slide was then brought to its normal position, irradiated, and cultured in a humid chamber. One or two runs were made in a constant temperature incubator, but this proved an unnecessary refinement, since the rate of growth was not measured. A period of eighteen hours at room temperature was allowed for development, which proved sufficient to give good growth of pollen tubes without permitting the growth of molds. In a few cases, pollen after sowing was stored in a refrigerator in a moist atmosphere at about 4° C for several hours before irradiation and culture. This proved permissible, since the pollen showed no visible tendency to germinate under these conditions, but was of undiminished vitality when brought to room temperature. In the majority of cases, pollen was sown from anthers plucked directly from young flowers. In the few instances where it became necessary to harvest pollen, anthers were stored over CaCl₂ in a refrigerator during the intervening period—procedure found quite satisfactory by Stout¹⁴ and Holman and Brubacher.¹⁵

Several means were adopted for convenience in counting the germinated cells. The best of these proved to be a modified balopticon, in which the image of the pollen, under approximately 50 diameters magnification, could be thrown on a cross-ruled screen and examined with both eyes uncovered through a viewing hood. A record of count of more than 20,000 grains was made.

The procedure adopted in the case of mold spores differed but slightly from that used with pollen. In the case of low voltage x-rays and cathode rays, mold

¹² Jost, L. Ber deutsch Bot Ges, 1907, 23, 504-515.

¹³ Brink, R. A. Am Jour 1924 Bot 1924 11, 283-294.

¹⁴ Stout, A. B. Unpublished communication.

¹⁵ Holman, R. M., and Brubacher, F. Univ Cal Pub Bot 1926, 13 (10) 179-204.

inches from the window instead of between two and four inches as with the mold spores, the increment being, as before, one-quarter of an inch

DISCUSSION

It seemed possible that the inactivation with x-rays or cathode rays might be due to other things than the primary beam, or the x-rays produced or electrons released within the tissues of the material. Secondary x-rays from the glass of the microscope slides, chemical changes brought about within the irradiated agar or even at the glass surface might well be considered vitiating factors. To check these points, agar samples were made up on glass slides, and after x-raying at the lower voltage, were sown with untreated pollen. Germination was perfectly normal. Agar samples were then made up on strips of cellulose acetate, inoculated with pollen, and rayed. The rate of inhibition was not appreciably changed, although the secondary radiation from the acetate would be supposed to be of a different character from that of the glass. The authors were satisfied that the order of magnitude of errors resulting from such effects was not such as to interfere with their results.

It is to be seen that mature pollen of the Easter lily exhibits a remarkable tolerance for x-rays and cathode rays, which is shared by other species in the case of the latter. A similar tolerance is evident with the molds. Thus, if the number of roentgens of incident energy be tabulated in runs for pollen grains and mold spores for the three energy sources in which the survival ratio fell nearest to 0.5, the result is as shown in Table VII. It will be noticed that, for the two materials, there is rather close correspondence in the energy input required to reduce the survival ratio to approximately the same figure.

It is interesting to read Table VII in the other direction, and consider, for the same material, the comparative energy required to reduce the survival ratio to approximately the same figure for the three energy sources. It will be seen that this input is greater with hard x-rays than with soft x-rays by a factor of about 2.1 for mold and about 6 for pollen. This deviation, although in the direction which might be expected, is probably of no significance in the case of mold, and certainly of none, for reasons later to be mentioned, in the case of pollen. The same is true for cathode rays.

To make certain that cathode-ray particles, known to discharge a very large proportion of their energy near the end of their paths, were not passing through the cell tissue and into the material behind it in quantity, the following experiment was undertaken. If this were true, it should be possible to lower the mean velocity of electrons in the cathode beam to the point where they would be absorbed in the cell tissue. If exposures be made with increasing filter thickness, it should be possible, at some point between normal killing and complete shielding, to produce a marked increase in effectiveness of the treatment, corresponding to a critical electron velocity. This experiment was carried out. Mold spores were exposed to the cathode beam in the usual fashion, at distances of 1, 2, 3, and 4 inches, in groups screened with one, two, and three "Resistol" windows of 0.6 mil thickness, exactly similar to that used on the tube itself. A control was run with each group, and survival ratios, obtained as usual, were as shown in Table VIII.

It will be seen that, although the survival ratio for each exposure increases progressively with increased shielding, there is in every case a smooth and regular decrease of survival ratio with increase of exposure. In no case is there any indi-

TABLE VII

Material	Soft X ray		Hard X rays		Cathode rays	
	S.R.	Energy input	S.R.	Energy input	S.R.	Energy input
Mold	0.47	8.4×10^4 r	0.45	$1.8-2.1 \times 10^5$ r	0.45	1.1×10^4 r
Pollen	0.57	3.0×10^4 r				

50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, and 170 minutes were made. In order to reduce the number of recorded trials, they were averaged in pairs, with the results shown in Table III.

Pollen—The procedure followed with pollen was the same as that with molds, except for differences in manipulation already indicated. It was decided, however, to omit the last two exposure groups given in mold in which, as with mold, negligible germination would take place.

CATHODE RAYS

Mold—Five runs were made with unfiltered cathode rays, involving a count

of 9,000 spores, the results being as shown in Table V.

Pollen—Two sets of runs were made with cathode rays, involving 5,283 grains. The first, including three sets of experiments, was done, as in the previous cases, only with pollen of *L. longiflorum*, and from this the energy value of inactivation used in comparison with the inactivating energy dose from other sources was taken. In the second series one of the runs of the first group is compared with runs of pollen of three other species under the same conditions. The results were quite closely similar. The inactivation range was such that exposures were made between distances of one inch and three

TABLE III

Test	Min 20-30	Min 40-50	Min 60-70	Min 80-90	Min 100-110	Min 120-130	Min 140-150	Min 160-170
1	0 93	0 80	0 64	0 54	0 43	0 21	0 26	0 00
2	0 87	0 90	0 49	0 56	0 35	0 30	0 05	0 00
3	0 87	0 66	0 18	0 07	0 01	0 00	0 00	0 00
4	0 79	0 78	0 44	0 38	0 26	0 15	0 03	0 04
5	0 85	0 76	0 50	0 46	0 14	0 07	0 00	0 02
Average	0 86	0 78	0 45	0 40	0 24	0 15	0 07	0 01

TABLE IV

Test	Min 20-30	Min 40-50	Min 60-70	Min 80-90	Min 100-110	Min 120-130
1	0 37	1 20	1 00	0 49	0 30	0 41
2	0 88	1 10	1 10	0 93	0 96	0 00
3	0 39	0 12	0 10	0 00	0 02	0 07
4	0 32	0 24	0 26	0 01	0 01	0 01 (120 only)
5	0 51	0 63	0 28	0 08	0 10	0 42 (120 only)
Average	0 49	0 66	0 55	0 30	0 28	0 18

TABLE V

Test	2 in	2 1/4 in	2 1/2 in	2 3/4 in	3 in	3 1/4 in	3 1/2 in	3 3/4 in	4 in
1	0 00	0 02	0 03	0 13	0 40	1 00	1 00	0 92	1 00
2	0 00	0 00	0 05	0 00	0 30	0 84	0 85	0 91	0 89
3	0 00	0 00	0 00	0 00	0 26	0 56	0 76	0 78	0 90
4	0 05	0 05	0 08	0 25	0 38	0 17	0 74	0 68	0 85
5	0 03	0 47	0 51	0 61	0 91	0 82	0 87	0 90	0 87
Average	0 02	0 11	0 13	0 20	0 45	0 68	0 84	0 84	0 90

TABLE VI

Test	1 in	1 1/4 in	1 1/2 in	1 3/4 in	2 in	2 1/4 in	2 1/2 in	2 3/4 in	3 in
1	0 00	0 00	0 01	0 01	0 00	0 02	0 00	0 05	0 32
2	0 00	0 00	0 00	0 00	0 00	0 00	0 04	0 04	0 07
3	0 00	0 00	0 00	0 01	0 50	0 39	0 82	1 00	1 11
Average	0 00	0 00	0 00	0 01	0 16	0 14	0 29	0 36	0 50
Species	1 in	1 1/4 in	1 1/2 in	1 3/4 in	2 in	2 1/4 in	2 1/2 in	2 3/4 in	3 in
<i>L. longiflorum</i>	0 00	0 00	0 00	0 01	0 50	0 39	0 82	1 00	1 11
<i>L. henryi</i>	0 00	0 00	0 00	0 03	0 79	0 89	1 11	0 70	1 00
<i>L. auratum</i>	0 00	0 00	0 00	0 01	0 87	0 84	1 11	0 72	1 00
<i>L. speciosum</i>	0 00	0 00	0 00	0 01	0 85	0 55	0 44	1 00	1 00
Average	0 00	0 00	0 00	0 02	0 75	0 67	0 87	0 86	1 04

biologic medium for radiation work. It has been found to possess many desirable properties but certain undesirable features which, if not technically overcome, will invalidate it as reliable material.

ACKNOWLEDGMENTS

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ionization chamber of his design which was used in measuring the energy of the soft x-rays, to Dr A B Stout, head of the Research Laboratory, New York Botanic Gardens, for his kindness in demonstrating to us his technic for the germination of lily pollens, and to Dr D K Berkey for his kindness in checking the calculations involved in the calibration of the cathode-ray tube and in supplying us with unpublished mass absorption coefficient data difficult or impossible of access in the literature.

TABLE VIII

Trial	1 Window				Control
	1 in	2 in	3 in	4 in	
1	0 00	0 00	0 76	1 00	1 00
2	0 00	0 02	0 75	0 95	1 00
3	0 00	0 03	0 57	0 82	1 00
4	0 00	0 00	0 56	0 71	1 00
5	0 00	0 00	0 89	1 00	1 00
Average	0 00	0 01	0 71	0 90	1 00

Trial	2 Windows				Control
	1 in	2 in	3 in	4 in	
1	0 00	0 67	1 00	1 00	1 00
2	0 42	0 96	1 00	1 00	1 00
3	0 00	0 64	0 87	1 00	1 00
4	0 00	0 78	1 00	1 00	1 00
5	0 00	0 50	0 76	1 00	1 00
Average	0 08	0 71	0 93	1 00	1 00

Trial	3 Windows				Control
	1 in	2 in	3 in	4 in	
1	0 00	1 00	1 00	1 00	1 00
2	0 76	0 74	1 00	1 15	1 00
3	0 26	0 54	1 00	1 00	1 00
4	0 56	0 65	1 00	1 00	1 00
5	0 56	1 00	1 00	1 00	1 00
Average	0 43	0 79	1 00	1 03	1 00

cation of a break such as would be expected if a critical electron velocity is required for killing

It is to be remembered that the treatment of data throughout has been purely qualitative and is to be taken as such. Only on this condition, for example, has it been considered justifiable to take averages of certain of the pollen readings.

It is evident that certain pollens possess properties which *a priori* recommend them for use as biologic media in radiation work. The pollen of the diploid lilies is susceptible to ready germination in artificial culture, requires but a few hours to attain a growth which will permit of a rapid statistical evaluation, is conveniently large, produces a tube which is non-branching and usually straight enough to be measured with fair accuracy, can be spread evenly, and can be readily cleared, if necessary, to view the nuclei. The disadvantages of the material are grave, however, and demand a refinement of technique without which pollen may well be disqualified for this work. Chief among these is the unusual capriciousness of germination, which has been emphasized by a number of workers,¹⁷ and notably by Brink,¹⁸ and with which

we have had extensively to cope. Variations in concentration of available oxygen and hydrogen, in hydrogen ion concentration of the medium, in humidity and temperature, are all reflected in germination rates and percentages. In addition, there is a large deviation depending upon the proximity of the grains to one another, as Brink has shown for *Cucumis* and *Nicotiana* and as we have been able to confirm for some of the lilies. Finally, there is a surprising variability, even from anther to anther of the same flower, in the viability of different samples of pollen germinated under the same conditions, which cannot be accounted for. These difficulties, however, are very largely technical, and it should be possible to overcome them.

CONCLUSIONS

Qualitative evaluations of the survival ratio curves of inhibition to pollen tube and mycelial growth in pollen grains and mold spores have been made with soft x-rays, hard x-rays, and cathode rays. Energy measurements have been made of the three sources in the same units, and a comparison of the incident energy inputs required to produce roughly equivalent survival ratios in the same material has been made for the three sources. The incident energy required for hard x-rays has been found greater than that for soft x-rays by a factor of about 2.1 for mold and about 6 for pollen—a disparity which may not be significant. The disparity between cathode rays and soft and hard x-rays is not considered significant.

A comparison has likewise been made of the relative resistance of pollen grains and mold spores to the same form of energy. The reaction of the two types of organism was closely similar.

A study has been made of the suitability of the pollen of the diploid lilies as a

¹⁷ Buchholz, J. T. and Blakeslee, A. F. *Am Jour Bot.*, July, 1927, 14, 353-369.

Futt, N. L., and Ayyar, G. G. *Agric Jour India* May 1928, 23, 190-202.

¹⁸ Brink, R. A. *Am Jour Bot.* April 1924, 11, 218-228.

it If the premature beat is one in which the contraction has taken place so early that the pressure is not sufficient to open

Heart block is detected by a comparison of the frequency of auricular and ventricular contractions Since the auricular

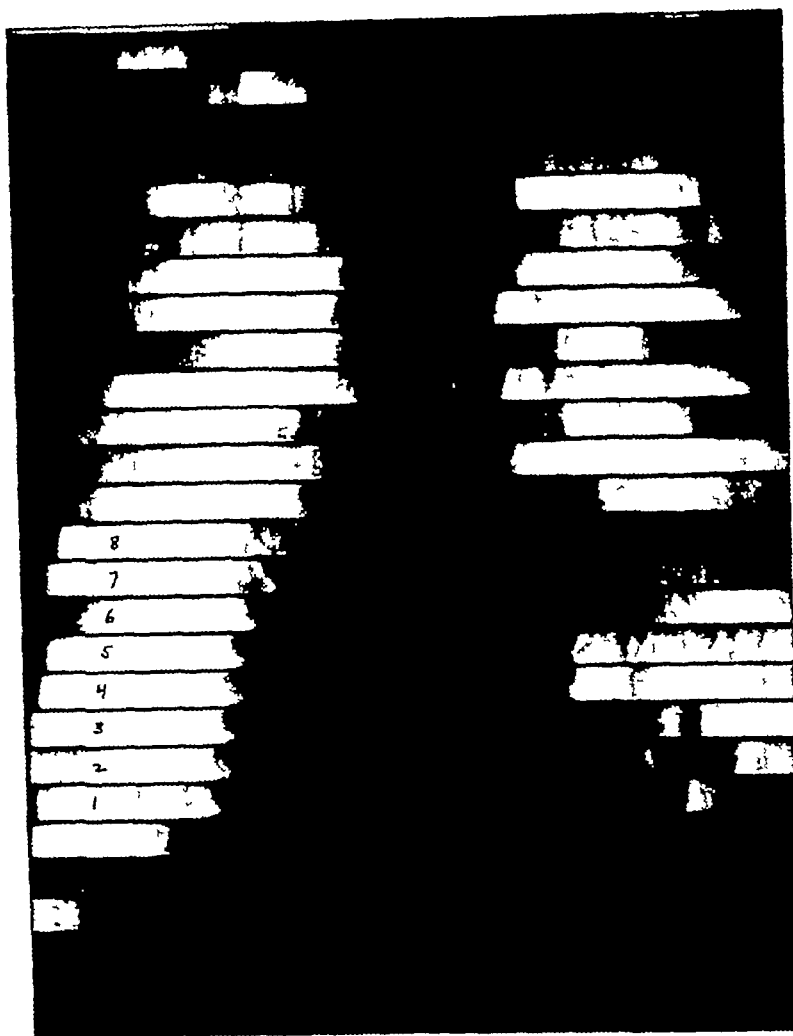


Fig 1 A Figs 1 A 1 B, and 1 C, are kymograms representing different types of heart action Slow ventricular waves are to be noted over the left contour in frames from 1 to 8 but also over the lower right contour in frames from 1 to 7 indicating that the lower right contour in the living is always formed by the right ventricle—more so in vertical than in horizontal hearts

the aortic valve, etc (frustrated contraction), no corresponding wave is registered on the aortic shadow On the other hand, the prolonged filling of the left ventricle, following the extrasystole and its sudden emptying after the compensatory pause, results in an aortic wave of increased amplitude When the extra-ventricular waves are visualized in the upper part of the ventricle only, they are not associated with corresponding aortic waves

waves do not now regularly bear the imprint of the ventricular wave, pure undeformed waves of auricular origin may be demonstrable There may be considerable variation in the number of auricular systoles that occur during ventricular diastole in the same frame The ventricular waves are irregular in sequence and amplitude, but generally show a marked increase in amplitude This is due to the effect of a greater number of auricular

THE APPLICATION OF KYMOROENTGENOGRAPHY TO THE DIAGNOSIS OF CARDIAC DISEASE¹

PART II

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IN the consideration of the application of roentgenkymography to the study of the abnormal heart it is important to understand at the outset that the kymographic wave is not a mystic symbol capable of expressing the particular disease of the heart. It expresses only the movement phenomena of the heart and indicates the deviation from the normal, only insofar as the particular lesion affects the movement.

Deviations of the kymographic waves from the normal may result either from

(1) Disturbances of rhythm which produce variations in the character and periodicity of the movements

(2) Intrinsic changes in the muscle itself, hypertrophy, atony, or degeneration

(3) Extracardiac influences which modify the anatomic relationships of the heart and the intrathoracic pressure changes

(4) Changes resulting from valvular defects which produce abnormal vibrations and variations in the chamber movements

(1) *Changes resulting from disturbances in the character and periodicity of movement*

*Cardiac Irregularities*²—By a study of

successive cycles, the presence of disturbance in rhythm may be demonstrated by noting the variations in the amplitude and time relationships of the waves. Sinus arrhythmias, extrasystoles, auricular fibrillation and flutter, and heart block may thus be graphically demonstrated.

In auricular tachycardia the compression which the waves undergo is such as to blot out their individuality, so that there is produced a blurred, serrated outline. In ventricular or nodal paroxysmal tachycardia, the auricular waves maintain a normal contour, as the frequency is not increased.

Each frame over the ventricular contour contains two or more waves, depending on the rate. The wave is high and its contours steep. The diastolic limb shows a relative shortening, and approximates a straight line. There may be a slight blunting of the apex of the wave, due to a relative slowing up of the presystolic outward movement. The sound phenomena vibrations are not usually visualized.

Ventricular extrasystoles may be recognized by finding over the left ventricular contour, an interruption of the sequence of regular waves, by a wave of smaller amplitude, the extrasystole. This is followed by a wave of enlarged amplitude with a slow diastolic rise. The systolic limb of the extrasystole is relatively slow as compared to the normal wave preceding it while that of the compensatory wave, after the extrasystole is longer than normal. The extrasystolic wave appears earlier in the apical than in the basal portion of the heart and travels upward.

The corresponding change in the movement traced by the aorta depends upon the time relationship between the premature beat and the normal beat which preceded

¹ Read before the Fourth International Congress of Radiology, Zurich, July, 1934.

² Paroxysmal tachycardias and premature beats (or extrasystoles) are of three types: auricular, ventricular, and nodal, depending on the origin of the 'ectopic' stimuli either in the auricles, ventricles or auriculoventricular node. The determination of the type is important because of the varying prognostic significance of the different types and because they may be associated with otherwise unrecognized heart disease. For the study of cardiac irregularities it is necessary to increase the number of cycles in each frame. This may be done by covering every other or every second and third slit and thus increasing the duration of movement of the recording surface. This has the deficiency of diminishing the number of movement points. It therefore becomes necessary to adjust the slits so that movements of special points of the cardiac contour are recorded, for instance the left ventricular contour, the left auricular contour, the right auricular contour and the vascular contour.

peaks over the entire right contour from diaphragm to the aortic shadow. On the ventricle the diastolic limb of the wave

(2) *Intrinsic changes in the musculature, hypertrophy, atony, or degeneration*
The kymographic waves are modified,



Fig 1-C Rapid heart action. Note the increase in number of the waves in each band. The striking changes in the physical density of the heart during the cycle of movement are shown by the alternating black and white zones in every band.

In 7 and 8 on the left side the peaks are blunted because they are now composite waves indicative of ventricular and auricular motion. Pure left auricular waves may be seen in frame 8 in the right contour. On the right side in 6 and 7 the frames bear a combined auricular and ventricular wave. In this habitus, therefore a small portion of the left auricle forms the upper right cardiac contour. In A the ventricular waves are rounded (sine form) the legs being curvilinear. In B the ventricular waves are trapezoid or pointed the legs being rectilinear. In C the ventricular waves are sharply peaked and steepled. The amplitude of the contraction over different portions of the left ventricle is practically the same. In A the heart action is slow. In B the heart action has a medium rate. In C the heart action is fast.

is prolonged and the systolic relatively shortened. The peaks are of unequal change depending on the extent of the muscular change.

Whenever excessive volumes of blood

systoles in cycles when the larger ventricular excursion is noted and to the increased left auricular pressure. The apical por-

In total block the two limbs of the ventricular waves may be practically identical in form

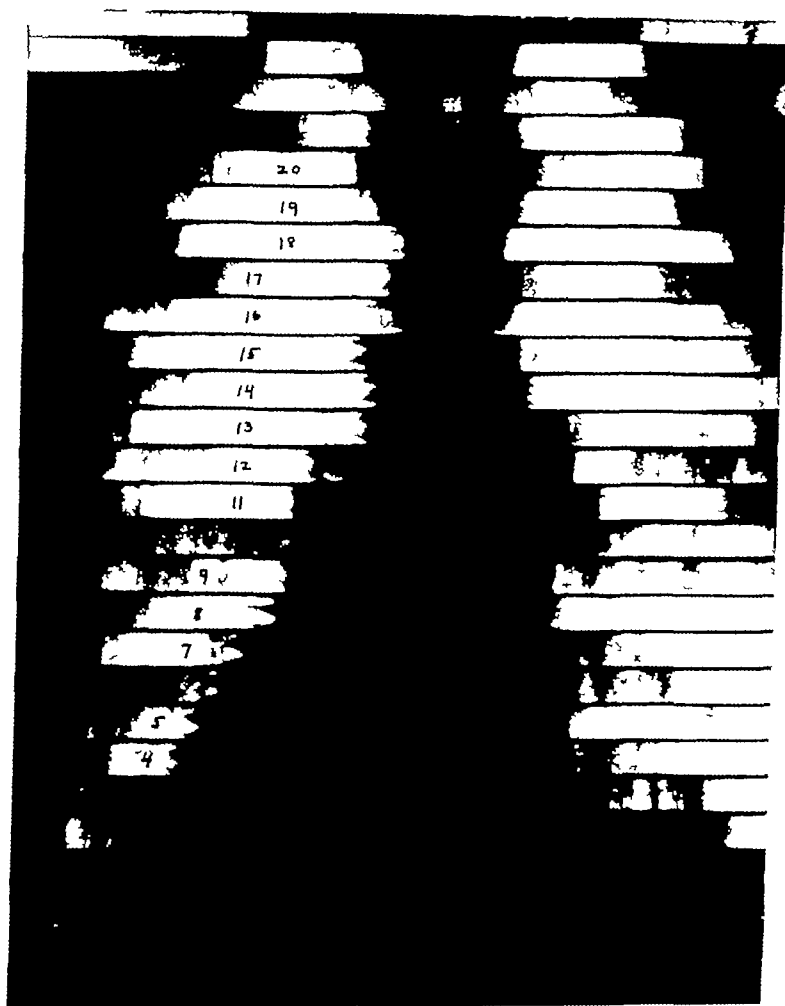


Fig 1 B The left ventricular contour in the lower nine frames bears prominent ventricular waves of practically equal altitude, indicating a uniform motion of all parts of this chamber. In the valleys of the ventricular waves in frames 8 and 9 are small peaks—left auricular motion. The auricular appendix (frames 10 and 11) shows motion of the ventricle and auricle—these frames showing two sharp peaks—auricular movement and two blunt waves—ventricular movement. Frame 12 shows the pulmonary artery waves and lateral to it waves indicating the movement of two parallel vessels which extend toward the apex. Frames 13 to 16 bear aortic waves. In 17 to 21 the waves are those due to motion of the left subclavian artery. Ventricular waves are seen over the lower right contour to frame 7. Frames 7 to 9 bear right auricular and ventricular while 10 to 14 show a continuation of high sharp aortic waves in the valley between which is a blunt peak—auricular in origin—motion transmitted into the vena cava.

tion of the wave is deformed by prominent serrations corresponding to the first heart sound. The location of the break on the diastolic limb varies in different waves

In auricular fibrillation the regular sequence of distinct and definite waves is replaced by irregular, ill-defined serrations, or there may be a complete absence of

In concentric hypertrophy of moderate degree, without dilatation, there is no change in the morphology of the wave. When, however, the dilatation is associated with hypertrophy well-defined waves are present only over the upper part of the ventricular shadow, the apical portion showing diminished movement. In cardiac failure the amplitude of the waves diminishes until it becomes barely perceptible and with this there are marked morphological and dimensional changes. When the waves of exaggerated amplitude change to waves of lessened amplitude, with a continued increase in the size of the heart, it is a sign of serious prognostic import. Small ventricular waves do not, however, always indicate myocardial insufficiency. Extremely small ventricular waves are present in certain cases of mitral stenosis when the left ventricle is small—the cardiac contour and size must be taken into consideration. Reduced apical movement is also commonly found in senile hearts, but is also found normally.

The left ventricular motion has been divided into two types by Stumpf. In Type I the amplitude of the kymographic wave is greatest at the apex, and in Type II the maximum amplitude of the kymographic wave is at the base. Stumpf states that a great majority of normal hearts show Type I movement and that although Type II is occasionally observed in normal hearts, it is seen regularly in pathologic hearts. This change in movement is interpreted in terms of structural changes, on the basis that hypertrophy or atrophy occurs in zones and only seldom affect the whole muscular apparatus uniformly. The outlet passage always hypertrophies first and to the greatest extent in the left ventricle, which brings about a change of the volume of the movement in corresponding zones, *i.e.*, increase in movement cranially (Type II).

The above conclusion for normal hearts are not confirmed in a series of 121 examination of young adults. While it is true that many hearts show a predominant motion at the apex (Type I) and others a

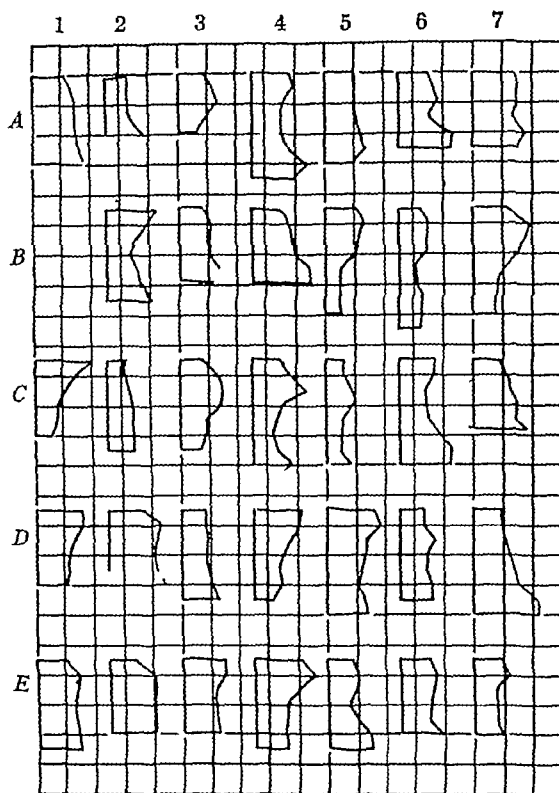


Diagram I Analysis of 34 kymograms showing the point of maximum movement of the left ventricular contour. Maximum amplitude at the apex is illustrated in C 6 D-7 E 5, and toward the base in B-7, C-1 and E-4. A-3 shows the greatest amplitude of motion in the middle portion of the ventricular contour while in B-2 and A-4 the amplitude is large at the apex and base and smallest in the middle region.

maximum movement toward the base (Type II), there is a large group which shows no gross preponderance at any one region. A few show maximum movement in the middle zone of the left ventricular shadow, although the amplitude of motion as a rule is least in the middle zone. Not infrequently there are found kymograms with large amplitude of motion both at apex and base with small movement in the middle. Type II movement is regularly found in normal hearts and by no means limited to pathologic hearts.

In a series of 121 cases, 80 showed a predominant movement varying from slight to marked, either at apex or base. Of these 80, 44 had movement greatest at the base (Type II), and in 36 the movement was greatest at the apex (Type I). The remaining 41 cases showed no preponderance



Fig 2-A

Fig 2-B

Fig 2-A Kymogram of normal young adult taken in inspiration

Fig 2 B Kymogram of same subject taken 10 seconds after the Valsalva procedure (deep inspiration, followed by forced expiratory effort with mouth and nostrils closed) There is to be noted first that the heart has grown generally smaller. It is also more rounded due to a protrusion in the left auricular region and the waves over the left ventricle have lost their peaks and have become blunted and rounded the second phase of diastole being practically a plateau. The heart has slowed down somewhat. The aortic contractions are of increased amplitude and the pulmonary artery waves are of diminished amplitude. Thus the heart empties itself more freely than it fills. Actually both margins particularly the right move inward with each cycle during the test. This reaction cannot be induced in hearts showing hypertrophy.

are returned to a chamber of the heart, or when the ejection is below normal, dilatation follows. The ventricles resist this stretching by virtue of a muscular tone inherent in the living normal cardiac muscle. When the normal resistance to stretching is diminished or lost through a reduction or loss of muscular tone, the diastolic distention becomes pathologic.

In beginning dilatation, the ventricular waves have considerable height, even in repose and respond to the slightest exertion by a further increase in altitude. The diastolic period seems shortened and the systolic period somewhat lengthened.

Under pathologic conditions of diminished tone, the systolic discharge is apparently kept normal or is actually some-

what increased by a compensatory mechanism—increased initial pressure. This is shown by the presence of ventricular waves, the diastolic limb of which is rounded (convex) and the systolic concave. The waves are devoid of sound phenomena. When the compensatory mechanism fails, the systolic discharge is apparently less than normal in spite of a much greater distention. This is shown by diminished ventricular movement. There may, in fact, be a complete abeyance of the movement of the apical portion of the heart, this contour bearing no waves and showing straight edges. Should the condition of the heart muscle improve under therapeutic measures, the waves may again be found over the contour.

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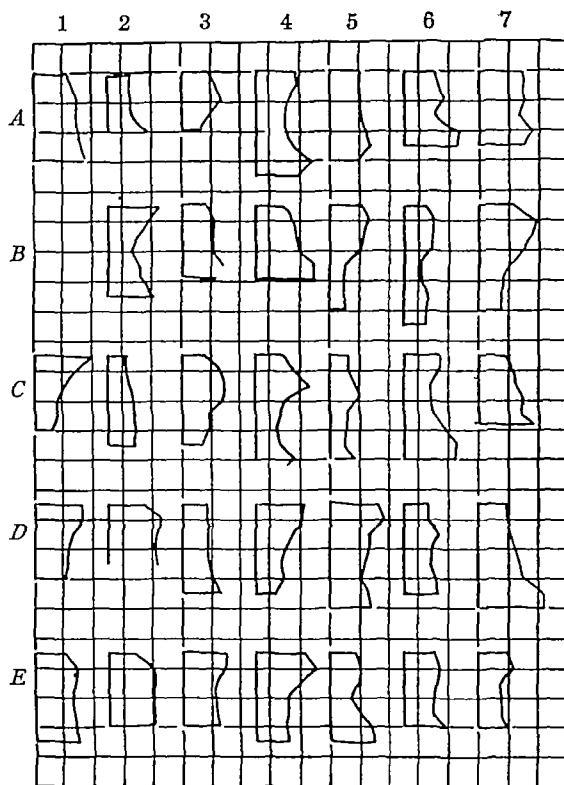


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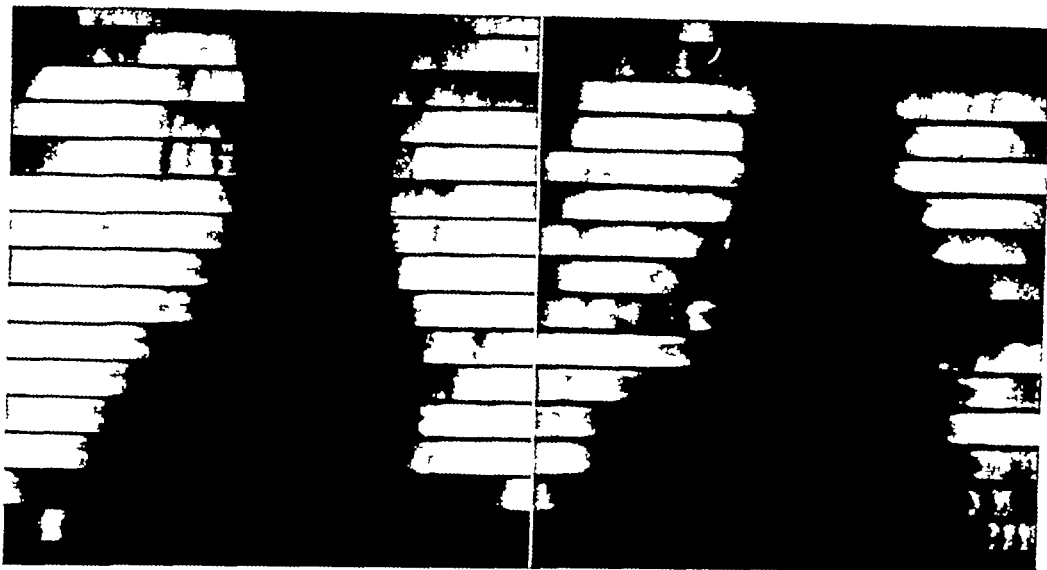


Fig 3 A

Fig 3 B

Fig 3 A Kymogram of a normal young adult taken in moderate inspiration

Fig 3-B Kymogram of the same subject taken 10 seconds after the Muller procedure (deep expiration followed by forced inspiratory effort with nose and mouth closed). There is to be noted in this figure that the heart has grown generally larger. It is the right heart which is primarily involved in this enlargement because the emptying of the right ventricle is retarded. The waves of the right ventricle have greater amplitude than those of the left. Prominent waves are noted over the vena cava shadow. The pulmonary artery pulsations are more prominent than the aortic. This is the counterpart of the picture of obstruction at the pulmonary valves or beyond it.

at any point, large amplitude at apex and base with smaller amplitude between, and in a few cases maximum amplitude in the middle region (Diag I)

To sum up the findings, it may be said that degenerative myocardial changes of sufficient severity to produce electrocardiographic changes are always associated with kymographic changes.

Degenerative changes in the aortic wall result in sclerosis, calcifications, and aneurysmal dilatations. Sclerotic changes of the aorta are ordinarily shown by a widening, elongation and tortuosity and a sharply projecting aortic arcus. The aortic waves usually show no deviation from the normal in simple sclerosis. The associated ventricular hypertrophy may, however, produce waves of increased amplitude. In the presence of calcification, the peaks become flatter and the amplitudes smaller. In annular calcifications of the entire aortic wall, this phenomenon is very pronounced. The lateral motion is of small amplitude, the point of maximum

dilatation is attained late, and the peak loses its characteristic sharpness. Nevertheless, distinct motion can be seen even in very marked calcifications.

In hypertension, the amplitude of the aortic waves is small, and the apex is blunted in spite of the large ventricular waves.

The amount and extent of movement in aneurysmal dilatations is variable, and depends on the extent of the clot formation in the wall of the sac. The characteristics of the aortic wave are not changed over the aneurysmal area, though a slight delay in point of time may be found on comparing the peak of the outward thrust to that of a wave over a normal portion of the aorta.

Aneurysms of the ascending aorta usually show very pronounced excursions. The form of the wave deviates from the normal. The inward and outward moving limbs resemble each other. In point of time, the peak of the wave is attained late—at the end of ventricular systole. The end of the medial motion is attained



Fig 4 Kymographic examination of the esophagus after the administration of a contrast bolus. A kymographic examination of the esophagus gives considerable information regarding the movement of the cardiovascular structures in relationship to it. In the ordinary fluoroscopic examination only the lower portion of the esophagus shows definite movement. The kymographic examination, however, shows that every portion of the thoracic gullet shows definite movement imparted to it by the particular cardiovascular structure in relationship to it. In the lower portion two waves are shown indenting the gullet shadow in each band, one due to auricular diastole and one to ventricular diastole. Above, the aorta imposes its movement in varying intensity upon different portions of the esophagus. Considerable information regarding the auricular movements may be obtained by this method because of the large extent of auricle in relationship to the gullet.

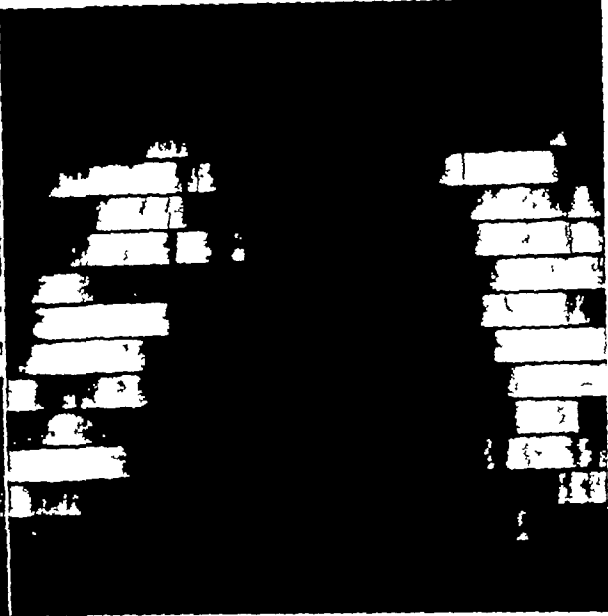


Fig 5 Hypertension. There is exaggerated movement of the left ventricle as shown by waves of considerable amplitude. The aortic waves are relatively low, a characteristic of hypertension. Even in this individual of the supersthenic habitus pure left ventricular waves are seen in the lowest bands on the right side.

simultaneously by all portions of the vessel.

Aneurysms of the descending aorta show as protrusions to the left, but may also show to the right. Aneurysmal sacs extending toward the right usually bear no waves.

The peculiar character of the wave over the aneurysmal sac, the wave with symmetrical limbs, permits the differential diagnosis of this lesion from mediastinal tumors either motionless or moved by transmitted pulsations.

The presence of small and thin areas of calcification, frequently not detectable on the ordinary roentgenogram, are clearly shown in the kymographic waves.

Aneurysms of the Heart—Partial an-

eurysms of the heart may be overlooked by fluoroscopy, not only when located in the apex or in the antero-inferior wall of the right ventricle, but even when located in the lateral aspect of the ventricle. When the pocket produces an actual localized projection of the left contour, the lesion may sometimes be isolated by the usual roentgenological methods. Partial aneurysms may, however, be shown kymographically by waves of diminished amplitude over a localized area of ventricular contour with normal waves above and below the area. This is also the finding when the sac is small. When an actual sac is present there is a definite reversal of the waves over a localized area. With each systole the inward moving limb is replaced by an outward diastolic movement because the walls of the sac, having lost their contractibility, the sac becomes distended by the systolic pressure in the ventricle. In other words, there is present in the ventricular contour a wave having the time and form characteristics of the aortic wave.

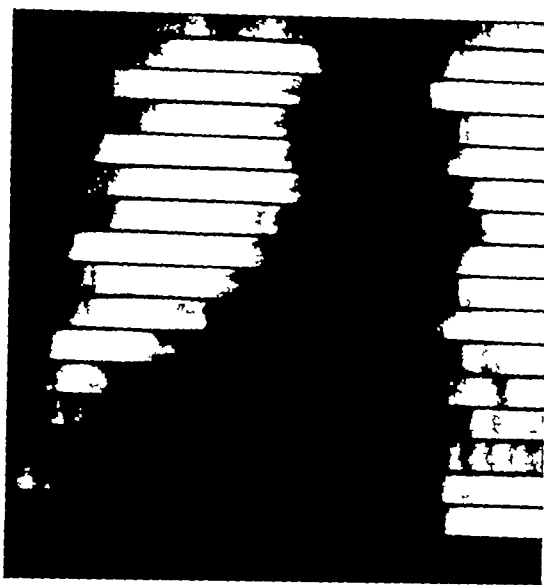


Fig 6 Kymogram of a case of aortic stenosis with marked left ventricular enlargement. Aortic waves of increased amplitude are seen over the entire aortic contour. Normal ventricular waves are present over the lower right contour (right ventricle). Over the lower part of the left ventricular contour, are waves which have the general characteristics of aortic waves. The peaks correspond almost exactly to the maximum ventricular systole. In other words, this portion of the heart contour moves outward when the remaining portions of the ventricle move inward. This would indicate an area of myocardial degeneration and a ventricular aneurysm.

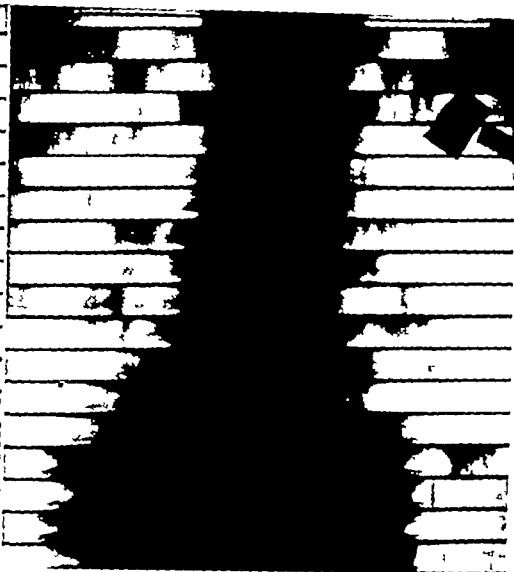


Fig 7 Kymogram and EKG of a case of syphilitic stenosis beyond the pulmonary valves with complete heart block. Note the exaggerated amplitude of the ventricular waves present on both sides of the cardiac contour—the right auricular waves of high amplitude are interposed between the ventricular waves. The pulmonary artery waves are more prominent than the aortic. A correlation with the EKG shows a variation in the shape of the diastolic limb of the ventricular wave due to a variation in the point of the break of the wave. This is due to the variation in the time of the auricular systole (P wave). The T wave does not end with the end of systole in every cycle. It seems to shift about.

(3) *Extracardiac influences which modify the anatomic relationships of the heart and the intrathoracic pressure changes*

The lungs appear to exert a dampening or cushion effect on the heart movements. Thus in pneumothorax, the waves over the particular portion of the heart in relationship to the air-containing cavity show a markedly increased amplitude, while pleural effusion and consolidation have the opposite effect on contiguous portions of the heart.

By giving a graphic record of the movement of structures, the kymogram is of value in the differential diagnosis of pericardial from cardiac lesions.

In pericardial effusion, the waves are markedly diminished in amplitude and ill-defined over the basal portions of the deformed median shadow, yet show good form and amplitude over the apical por-

tion. In cardiac hypertrophy the waves may be diminished over apical portions of the heart, but the upper part of the ventricular contour shows characteristic waves. However, in large effusions there is a lack of clearly defined waves over the entire median shadow. Density changes, corresponding to systolic and diastolic volume of the heart may, however, be made out, and the heart contour may be recognized in the sac.

The distortion of the lower left cardiac contour and the left apex by a mediastinal pleural exudate extending to the left can be differentiated from heart form of pericardial effusion by the finding of kymographic waves of unchanged amplitude and form, over the area.

Calcification of the pericardium does not modify the size or character of the waves to any appreciable extent. Pleuro-peri-

cardial adhesions, however, diminish the amplitude of the waves over the involved area

The kymogram is of value for the determination of the significance of distortions of the upper median shadow. Fluoroscopy does not always permit of the differentiation of the vascular pulsations from the transmitted movements, and the kymographic study is helpful under such circumstances. Tumors, substernal thyroids or cysts, etc., usually show no movement waves. A deformity of the median shadow due to aortic dilatation would show definite aortic waves associated with density changes. The transmitted pulsations show as waves without density changes.

Tumors of the mediastinum are generally motionless. Encysted effusions may show transmitted pulsations.

Besides this, the entire extent of the pulsating structure may be studied in the conglomerate shadow of the mediastinum, and the continuity of shadows, otherwise demonstrable with difficulty, may be determined. Thus the entire extent of the aorta may be determined with ease in the kymogram.

(4) Modification of the kymographic waves resulting from changes due to valvular defects

Among the results of valvular disease are (1) A variation from the normal state of filling of the chambers related to the valve involved, (2) Secondary and compensatory changes in the muscle walls.

The valvular lesions are manifested by (1) Changes in the distribution of the waves, (2) Changes of the character of the waves and their dimensional relationships, (3) Changes in time relationships of the various phenomena of the cycle, (4) Changes in the vibrations associated with the sound phenomena.

It is important to attempt to distinguish between the effects of the disturbed valvular action and effects of the abnormal anatomic and physiologic activity of the myocardium—not a simple task at this stage of the art of kymographic diagnosis.

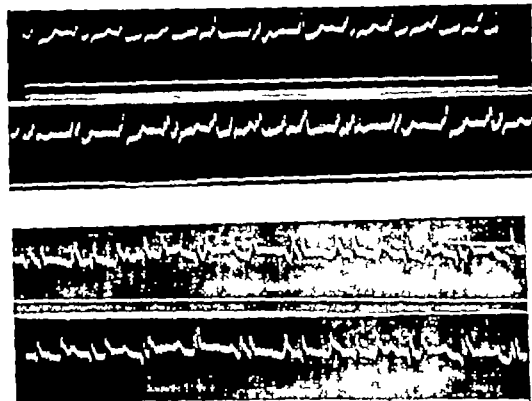


Fig 7

A clue to the changes produced by variations from the normal state of filling of the chambers may be found by making kymographic examinations during such procedures as the Muller and the Valsalva tests, which, by producing changes in intrathoracic pressure, artificially reproduce some of the changes found in organic lesions.

A kymogram made during the Muller test illustrates how the heart chambers accommodate themselves to a temporary ventricular overfilling. This test produces an effect similar to that which exists when there is an obstruction to the flow of blood from the right ventricle, as, for instance, in stenosis of the pulmonary artery, or an obstruction in the pulmonary circulation. The kymographic exposure is made a few seconds after a maximum expiration, followed by an inspiratory effort with nostrils and mouth closed. It shows graphically, a rapid enlargement of the heart with each cycle and growing prominence of the right contour waves over the left, both auricular and ventricular. The waves on the vena cava shadow are of increased amplitude, while the aortic waves show diminished amplitude (Fig 3).

A kymogram made during the Valsalva test illustrates how the heart chambers accommodate themselves to a decreased inflow. By this procedure the heart is gradually emptied of blood. The kymographic exposure is made a few seconds after a maximum inspiration, followed by

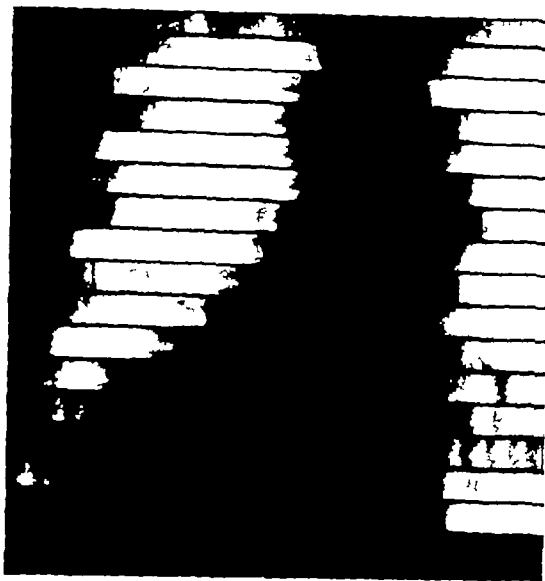


Fig 6 Kymogram of a case of aortic stenosis with marked left ventricular enlargement. Aortic waves of increased amplitude are seen over the entire aortic contour. Normal ventricular waves are present over the lower right contour (right ventricle). Over the lower part of the left ventricular contour, are waves which have the general characteristics of aortic waves. The peaks correspond almost exactly to the maximum ventricular systole. In other words, this portion of the heart contour moves outward when the remaining portions of the ventricle move inward. This would indicate an area of myocardial degeneration and a ventricular aneurysm.



Fig 7 Kymogram and EKG of a case of syphilitic stenosis beyond the pulmonary valves with complete heart block. Note the exaggerated amplitude of the ventricular waves present on both sides of the cardiac contour—the right auricular waves of high amplitude are interposed between the ventricular waves. The pulmonary artery waves are more prominent than the aortic. A correlation with the EKG shows a variation in the shape of the diastolic limb of the ventricular wave due to a variation in the point of the break of the wave. This is due to the variation in the time of the auricular systole (P wave). The T wave does not end with the end of systole in every cycle. It seems to shift about.

(3) *Extracardiac influences which modify the anatomic relationships of the heart and the intrathoracic pressure changes*

The lungs appear to exert a dampening or cushion effect on the heart movements. Thus in pneumothorax, the waves over the particular portion of the heart in relationship to the air-containing cavity show a markedly increased amplitude, while pleural effusion and consolidation have the opposite effect on contiguous portions of the heart.

By giving a graphic record of the movement of structures, the kymogram is of value in the differential diagnosis of pericardial from cardiac lesions.

In pericardial effusion, the waves are markedly diminished in amplitude and ill-defined over the basal portions of the deformed median shadow, yet show good form and amplitude over the apical por-

tion. In cardiac hypertrophy the waves may be diminished over apical portions of the heart, but the upper part of the ventricular contour shows characteristic waves. However, in large effusions there is a lack of clearly defined waves over the entire median shadow. Density changes, corresponding to systolic and diastolic volume of the heart may, however, be made out, and the heart contour may be recognized in the sac.

The distortion of the lower left cardiac contour and the left apex by a mediastinal pleural exudate extending to the left can be differentiated from heart form of pericardial effusion by the finding of kymographic waves of unchanged amplitude and form, over the area.

Calcification of the pericardium does not modify the size or character of the waves to any appreciable extent. Pleuro-peri-

ventricular waves as under normal conditions in its lowermost portion

When, on the contrary, there is marked

enlargement The typical findings of shape and size of the heart shadow must be present With an increased obliquity of the

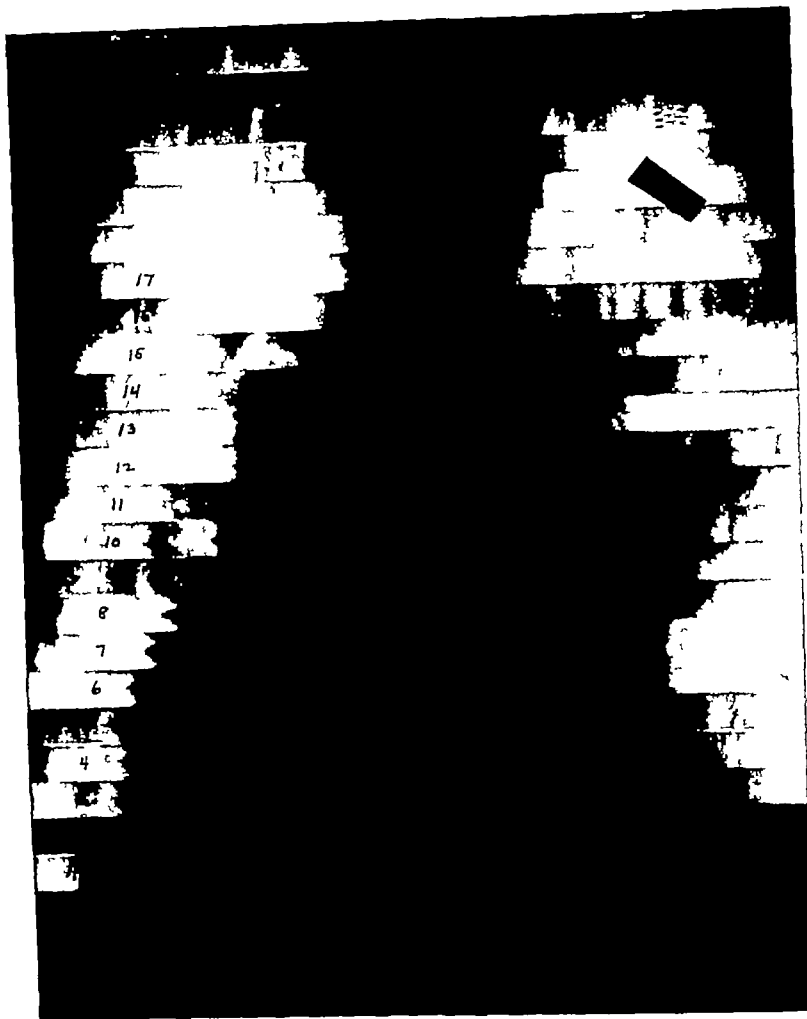


Fig 9 Double mitral lesion. Dyspnea cyanosis edema large liver. Loud systolic murmur over the whole cardiac region propagated to the axilla and back. Presystolic rumbling at the apex. EKG shows complete arrhythmia with auricular fibrillation. The kymograph shows the typical contour of double mitral valvular disease with marked dilatation of the left auricle. The right contour bears flat ventricular waves synchronous with those on the left contour. There is also marked pulsation of the pulmonary arteries. There is marked dilatation of the pulmonary artery, particularly on the right side where low rounded waves may be seen. On the left side, the pulmonary artery has been pushed up by the markedly dilated left auricle.

enlargement of the left ventricle, the intra-ventricular septum is displaced to the right and the right ventricle may form a larger part of the right contour. However, an increased number of ventricular waves over the right contour by no means indicates by itself that this is due to left ventricular

heart's axis, as in the subthentic habitus or with low position of the diaphragm, an increased extent of ventricular waves to the right may be observed normally.

It is conceivable, also, that an aneurysm of the intraventricular septum may push the right ventricle outward to such a de-

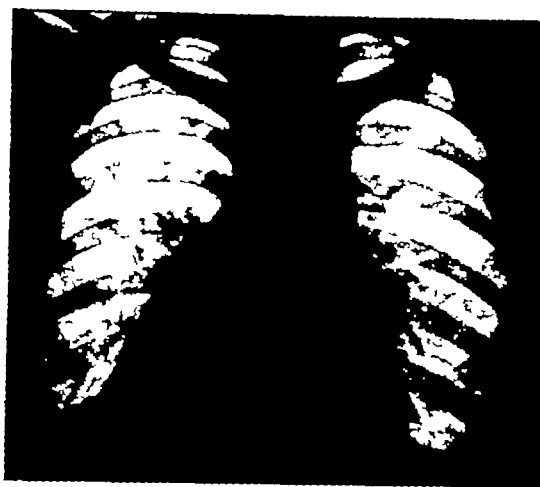


Fig 8 A



Fig 8-B

Fig 8 Kymogram of a case of mitral stenosis and insufficiency. *A* Regular examination, *B* Kymographic examination. The characteristic contour may be made out. Note the inconspicuous aortic waves, the prominent pulmonic and auricular waves. The ventricular waves are also prominent over almost the entire right contour. The first phase of diastole is shown as a straight line without the usual break. Then follows a plateau indicating the absence of movement of the left ventricle, to be followed by a rapid systole. On the right side the waves over the lower portion also show this characteristic while over the upper portion of the right contour, the waves are rounded. The sound waves do not show.

a forced expiration with mouth and nostrils closed. The emptying of the heart exceeds the filling with each cycle and the kymogram shows graphically how the heart grows smaller in size with each contraction. All parts of the heart are simultaneously affected. The margins continue to move in until the heart attains its minimum dimension. The ventricular and auricular waves show a gradually diminishing amplitude with increase in the intrapulmonary pressure (Fig 3).

The changes in the size and shape of the chambers, which give the cardiac silhouette its characteristic shape in various valvular lesions, naturally modify the normal distribution of the kymographic waves.

The accentuation of the right contour as found in organic lesions of the heart may be due to either enlargement of the right auricle or of the left auricle. If due to the right auricle, the whole profile may bear auricular waves which may show peaks surmounting in altitude those imposed on the auricular contour by the ventricle.

In consideration of the changes produced by left auricular enlargement it is

important to understand that the cavity of the left auricle, sometimes normally, but always under pathologic conditions, may not only extend to the left, in back of the pulmonary artery, but may also extend to the right, sometimes only to the right, behind and above the right auricle. The right contour now consists in its upper third of the left auricle, which overlaps the aortic shadow above and the right auricular shadow below. But under such conditions, the kymographic waves of the upper part are not auricular in time or character, for the contour passively follows the movement of the ventricle, being thrust out with the ventricular systole. The intrinsic left auricular movements are too feeble to be recorded. This is frequently observed in mitral valvular disease.

The lower right contour is not deviated by changes in the right ventricle. When the right ventricle enlarges, it does so not to the right, but to the left, and downward. Thus in pure right ventricular enlargement, such as follows congenital pulmonary stenosis or syphilitic stenosis of the artery beyond the valves or in a patent ductus, the right cardiac contour may show

It then follows passively the exaggerated movement of the ventricle. This explains the waves resembling aortic waves there is a very prominent notch imposed on the retracting limb in the pulmonic wave which corresponds in time to the

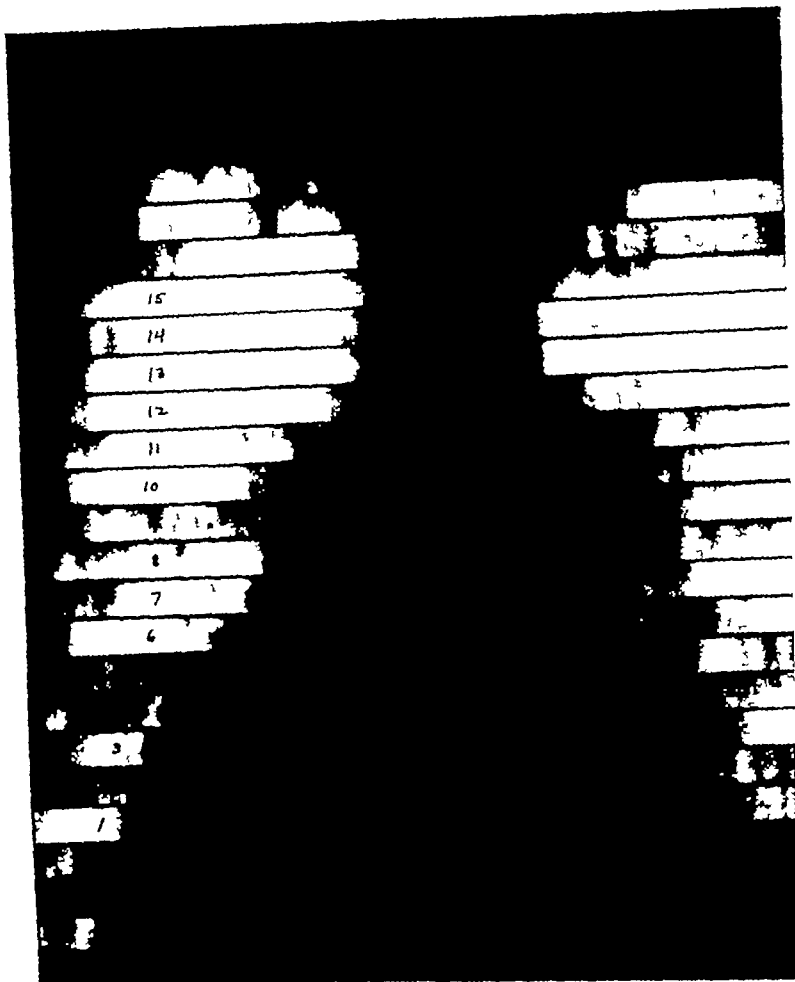


Fig 11 Kymogram of a case of combined valvular disease. The aortic waves are not seen over the descending arch shadow. The amplitude of the waves is small. The ascending limb (outward thrust) rises slowly. The pulmonary artery is dilated. The right auricular contour bears auricular waves of considerable amplitude. There is practically no movement over the apical portion of the heart. Towards the base the ventricular waves show a slow primary diastolic phase, which is followed by a period during which the ventricle either makes no further outward movement, or makes an inward movement (the rounded peak of the wave). This is then followed by a short sharp systole. The maximum dilatation of the descending arch is not attained until left ventricular systole is fully ended. The pulmonary artery reaches maximum dilatation in advance of the maximum aortic dilatation.

over the upper part of the right cardiac contour. When the regurgitation is marked, the first sound notch disappears, particularly when decompensation is present.

The pulmonary artery waves are of greater amplitude than the aortic, and

second sound. There is also a strong pulsation of the lung vessels extending to the periphery, which becomes very marked in decompensation.

The striking features of the kymographic examination in mitral valvular disease are (a) changes in the character of the

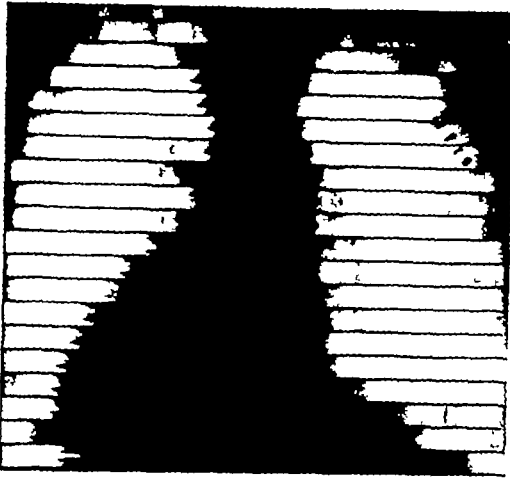


Fig 10 Kymogram of the heart of aortic insufficiency. The maximum dilatation of the ascending arch is practically synchronous with the closure of the mitral but the peak on the descending arch is attained relatively late. The failure of the aortic valves to close produces the dilatation of the ascending arch immediately, the delay in the full dilatation of the descending arch is compensatory for the establishment of the necessary ventricular aortic pressure. On the ascending arch the aortic wave rises rapidly, falls back slowly at first and then drops suddenly and sharply. On the descending arch the wave rises rapidly, falls back sharply and then retracts slowly. The left auricular waves are exceedingly prominent. The vibration associated with the second sound shows in an exaggerated form over the ventricles but the first sound vibration cannot be made out. EKG shows P notched, QRS slurred, T inverted sinus tachycardia.

gree as to produce well-marked ventricular waves over the entire right contour.

MITRAL DISEASE

In insufficiency, at the instant diastole begins, there is a rapid and extensive dilatation of the ventricle due to a large volume of blood entering it, shown by the shape of the first portion of the diastolic limb of the left ventricular wave. There then follows a slow, relatively long terminal portion of diastole, as if the ventricle then remained practically motionless after the first flood-like filling, until systole begins. This terminal diastolic movement may even show an inward or mesial sloping instead of an outward movement as normal, the inversion being more marked as the base of the heart border is ap-

proached. The systolic limb is normal in character.

In mitral stenosis, on the other hand, the diastolic limb shows as a uniform line without break due to slow filling of the ventricle.

In mitral stenosis there is marked deformity at the apex of ventricular wave due to phenomena associated with the production of the first sound. In fact, when such deformity is marked, and the rhythm is regular, the diagnosis of a tight stenosis is corroborated, if the characteristic heart shape is present. The systolic limb is relatively rapid and the systolic discharge is reduced as shown by the low amplitude of the aortic waves.

During ventricular systole there is normally an increase in the volume of the auricle. In mitral insufficiency this increase during ventricular systole is very marked. The extent depends on the degree of insufficiency, the tonicity of the muscle, and extent of the dilatation of the chamber. In minor degrees of insufficiency, with but slight dilatation, the hypertrophy of the auricular walls is a compensatory element which may counteract this influence. But usually this compensatory mechanism is not operative. With beginning ventricular diastole, the auricular volume diminishes rapidly.

The left auricle appears to bear the brunt of the back pressure effects. Since insufficiency of the valve causes the mean left auricular pressure to rise during ventricular systole (when it should fall), a movement, ventricular in time, of increased amplitude, is present over the contour at the beginning of systole, not only in the usual area but also over the upper half or more of the right contour. In some cases almost the entire right contour may now show this movement. However, in some cases true auricular systolic phenomena may also be observed in addition.

When the left auricle is excessively dilated, its walls have the character of a thin aneurysmal sac, over-distended by the blood flowing back from the left ventricle.

changed hydrostatic conditions in the ventricles

It is not yet possible to define exactly the value of the contribution of this newer method of roentgen examination, to the anatomic, physiologic, and clinical study of the heart, nor all its possible applications. The data already obtained would, however, indicate that its field of usefulness will be wide and that it will assist greatly in the solution of many difficult problems in the field of cardiodynamics. Thus the action of drugs on the heart muscle may be studied by roentgenkymography, utilizing as criteria the difference in the frequency and amplitude of the wave, and the changes in the movement of the pulmonic vessels, before and after the administration of the drug. So also, attempts have been made to determine the heart volume by comparing the systolic and diastolic areas as shown by the kymographic waves and utilizing the formula of Bardeen

SUMMARY

The kymographic method contributes the following information to the morphologic and physiologic study of the heart

- 1 The actual make-up of the cardiac shadow
- 2 The shape of the heart as a whole, or any of its chambers during the various phases of movement
- 3 Size of the heart in systole and diastole or any intermediate phase
- 4 Characteristics of the movement of the heart as a whole or its various chambers
- 5 Activity and accomplishment of the cardiac muscle
- 6 The relationship of contraction to conduction phenomena
- 7 The relationship of movement to sound phenomena
- 8 A graphic representation of rhythm disturbances
- 9 The extent and severity of myocardial changes
- 10 The modification of the character distribution and time relationships of the chamber movements in valvular disease

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diastolic limb of the ventricular waves (rapid filling in insufficiency, slow filling in stenosis), (b) changes in the character and distribution of the waves of the left auricle, (c) changes in the character and distribution of the pulmonary artery waves

AORTIC DISEASE

When the aortic orifice is moderately narrowed the increased systolic activity maintains a normal systolic discharge and the aortic waves are not changed. The only abnormality consists in evidence of increased activity as shown by left ventricular waves of great amplitude and very frequently also accompanied by high right ventricular waves.

If stenosis is very great, there is less efficient emptying of the left ventricle in spite of the fact that intraventricular pressure during the systole rises to a great height and in spite of the lengthening of the period of systole. This reduces systolic discharge and lowers the amplitude of the aortic waves. In contrast, the pulmonary artery waves are prominent. The sound wave is imperceptible.

Over the left auricular area are prominent mixed auricular-ventricular waves. If myocardial weakness does not supervene, the blood is accommodated in the left auricle and its venous tributaries.

When muscular changes finally supervene, the left ventricle is dilated by a large volume of retained blood and a relative mitral change may occur.

In aortic regurgitation the ascending aorta begins to dilate, as shown by the out-thrust of the aortic waves, practically simultaneously with the onset of ventricular systole. This premature dilatation is practically simultaneous with the closure of the mitral valve and the first sound and is due to a wave transmitted through the incompetent semilunar valve. There follows then a sudden retraction of the vessel wall. This primary peak is more prominent nearer the heart and diminishes as distance from the semilunar valves increases and is not at all registered in the descend-

ing arch. There then follows a slower second rise (peak 2) on the ascending arch synchronous with a similar rise in the descending arch. This is the true aortic wave. On the descending arch the apex of this peak is sometimes split. Then follows a very prominent incisura corresponding to the second sound and a third peak with a very rapid retraction. In the upper bands over the descending arch, a fourth peak is evident. On the descending arch following the sound indentation and the second peak there is a very rapid retraction of the vessel.

The amplitude of the aortic waves is markedly increased.

The first period of ventricular filling takes place very rapidly, as shown by the steep high first portion of the diastolic limb. The second phase is slower and longer. The end of the diastolic period is marked by a sharp peak (steep) due to the increment contributed by the auricular systole. The systolic movement is delayed but of increased amplitude. It may, in fact, be stated that in aortic disease the greatest part of the diastolic filling takes place toward the end of diastole.

The valleys of the ventricular waves over the apex of the heart are clear, but near the base there is interposed a peak which corresponds to the beginning final retraction of the aorta (peak 3) and the period of collapse of the pulse. It represents the effect of the regurgitant wave and is apparently manifested predominately at the base and scarcely at all in the apical portion of the heart. The first sound sensation is of diminished amplitude. The left auricular waves are prominent at the base of the shadow of the ascending arch.

The striking features of the kymographic examination in aortic valvular disease are (a) disturbed time relationships between the aortic and ventricular kymograms, (b) qualitative changes in the contour of the aortic waves resulting from the regurgitation and the compensatory vascular phenomena, (c) qualitative changes in the ventricular waves resulting from the

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Equations (2) and (4) give a means of calculating the effective dose in double field work as, for example, in abdominal radiation. A roentgen dose of r units may be applied to the posterior and anterior sides of the abdomen on alternate days, respectively. When the anterior side is radiated, the posterior receives a dose μr , where μ denotes the percentage of the beam that remains after it has passed through the body. Similarly, when the posterior side is radiated, the anterior receives a dose μr . Thus, if treatment is started by giving the anterior side a dose of r (roentgens) the first day, and is continued by giving the same dose on the posterior side the second day, etc., the effective dose for the anterior side just after the dose has been given on the n th day is

$$D_e = \{rk + \mu r\} \left\{ \frac{1 - k^n}{1 - k^2} \right\} \quad (n \text{ even})$$

$$= r \left\{ \frac{1 - k^{n+1}}{1 - k^2} \right\} + \mu kr \left\{ \frac{1 - k^{n-1}}{1 - k^2} \right\} \quad (n \text{ odd})$$

There is a similar set of equations for the posterior side

$$D = \{\mu rk + r\} \left\{ \frac{1 - k^n}{1 - k^2} \right\} \quad (n \text{ even})$$

$$= \mu r \left\{ \frac{1 - k^{n+1}}{1 - k^2} \right\} + rk \left\{ \frac{1 - k^{n-1}}{1 - k^2} \right\} \quad (n \text{ odd})$$

Equations (2) and (4) may be used also to calculate the effective dose at various depths by giving D_e and D_a in terms of the appropriate percentages of the primary beam. The use of these equations assumes, of course, that tissue at various depths possesses the property of recovery mentioned above.

If dosage is stopped, the effective dose, D_e , will diminish as the tissues recover. On the first day after dosage is stopped, the effective dose will be $D_e k$, on the second day it becomes $D_e k^2$, and on the p th day it becomes $D_e k^p$. In practice it may happen that dosage is given throughout the week except for Saturday and Sunday, and thus for several weeks in succession. In double-field work of this kind the effective dose for the anterior for the week is

$$D_e = r \left\{ \frac{1 - k^{n+1}}{1 - k^2} \right\} + \mu kr \left\{ \frac{1 - k^{n-1}}{1 - k^2} \right\} \quad n = 5$$

This will depreciate to $D_e k^3$ over the week-end (since Monday is the third day after Friday). If dosage is resumed on that Monday and continued in this intermittent fashion for w weeks, the total effective dose for the period will be

$$D_{et} = D_e k^3 k^{7(w-1)} + D_e k^3 k^{7(w-2)} + D_e k^3 k^{7(w-3)} + \dots + D_e k^3$$

$$= D_e k^3 (k^{7(w-1)} + k^{7(w-2)} + k^{7(w-3)} + \dots + 1) \quad (5)$$

The series in the parentheses is a geometrical progression of which the first term is 1, the common factor k^7 , and the number of terms is w

$$D_{et} = D_e k^3 \left\{ \frac{1 - k^{7w}}{1 - k^7} \right\} \quad (5.1)$$

Thus if dosage is given alternately, as described above, from Monday to Friday and resumed in exactly the same manner the following Monday, for w weeks, Equation (5.1) gives the total effective dose at the beginning of the Monday w weeks later.

If, in Equations (2) and (4), we let $D_e = D_a = D$, we have n even,

$$D_e = \{Dk + D\} \left\{ \frac{1 - k^n}{1 - k^2} \right\} =$$

$$D(k + 1) \left\{ \frac{1 - k^n}{1 - k^2} \right\} = D \left\{ \frac{1 - k^n}{1 - k} \right\}$$

n odd,

$$D_e = D \left\{ \frac{1 - k^{n+1}}{1 - k^2} \right\} + kD \left\{ \frac{1 - k^{n-1}}{1 - k^2} \right\} =$$

$$\frac{D}{1 - k^2} (1 + k - k^n - k^{n-1}) = D \left\{ \frac{1 - k^n}{1 - k} \right\}$$

Thus, the expressions for D_e for n even and for n odd become identical when the alternating doses become identical. In other words, if the same dose is given for n days, the effective dose is

$$D_e = D \left\{ \frac{1 - k^n}{1 - k} \right\} \quad (8)$$

If the dose is given every other day, our k becomes k^2 , if it is given every third day, k becomes k^3 , if it is given every m th day, k becomes k^m . Likewise, n becomes $(n - 1)/2$, $(n - 2)/3$, $[n + (m - 1)]/m$. Substituting in (8),

$$D_e = D \left\{ \frac{1 - (k^m)^{[n + (m - 1)]/m}}{1 - k^m} \right\} = D \left\{ \frac{1 - k^{n + m - 1}}{1 - k^m} \right\} \quad (9)$$

SOME MATHEMATICAL ASPECTS OF RADIATION DOSAGE

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It is found that tissue exhibits a property of "recovery from radiation effects"

The rate of recovery is generally assumed to be exponential (1 and 2) Due to this property of recovery, the effective radiation dose (sometimes called cumulative) tends toward an equilibrium value, that is, a value at which the rate of recovery of the tissue equals the rate of dosage

Assuming the fact of tissue recovery we will derive an expression for the effective (or cumulative) dose at the time just after it has been administered on the n th day Since recovery begins the moment energy is absorbed by the tissue, we shall, for a first approximation, assume that the dose is administered instantaneously To cover cases in which different doses are given on alternate days we shall take the case wherein D_i , the initial dose, alternates with a dose D_a on subsequent days Let β be the recovery factor of the tissue for unit time Thus β may be 4 per cent per day (3) as in the case of radium radiation filtered through 1 mm of platinum, or it may be 8 per cent per day (2) as in the case of roentgen radiation of $\lambda_{\text{eff}} = 0.16 \text{ \AA}$ Let $k = (1 - \beta)$, or the amount of radiation effect remaining after one day

First there is the case when n is odd The contribution of the first day, A_1 , to the effective dose will be $D_i k^{n-1}$, the contribution of the second day, B_2 , will be $D_a k^{n-2}$, etc Thus

$$\begin{aligned} A_1 &= D_i k^{n-1} \\ B_2 &= D_a k^{n-2} \\ A_3 &= D_i k^{n-3} \\ B_4 &= D_a k^{n-4} \end{aligned}$$

$$\begin{aligned} B_{n-2} &= D_a k^{n-(n-2)} \\ A_{n-1} &= D_i k^{n-(n-1)} \\ B_{n-1} &= D_a k^{n-(n-1)} \\ A_n &= D_i k^{n-n} \end{aligned}$$

The effective dose after n days is equal to the sum of the A 's and B 's But

$$\begin{aligned} \sum A_i &= D_i (k^{n-1} + k^{n-3} + k^{n-5} + \dots + k^{n-(n-2)} + 1) \quad (1) \\ \sum B_i &= D_a (k^{n-2} + k^{n-4} + k^{n-6} + \dots + k^{n-(n-3)} + k) \\ &= D_a k (k^{n-1} + k^{n-3} + k^{n-5} + \dots + k^{n-(n-2)} + 1) \quad (1.1) \end{aligned}$$

The series in the right-hand sides of Equations (1) and (1.1) are geometrical progressions of which the first term a is equal to 1, the common factor $d = k^2$, and the number of terms are $z = (n+1)/2$ The sum of such a progression is $S = \frac{a - ad^z}{1 - d}$

Hence for the above series

$$\sum A_i = D_i \left\{ \frac{1 - k^{2(n+1)/2}}{1 - k^2} \right\} \quad \sum B_i = D_a k \left\{ \frac{1 - k^{2(n+1)/2}}{1 - k^2} \right\}$$

The effective dose, D_e , is then

$$D_e = D_i \left\{ \frac{1 - k^{n+1}}{1 - k} \right\} + k D_a \left\{ \frac{1 - k^{-1}}{1 - k^2} \right\} \quad (n \text{ odd}) \quad (2)$$

When n is even, the contribution of the first day, A_1 , is $D_i k^{n-1}$, that of the second day, B_2 , is $D_a k^{n-2}$, etc, whereas

$$\begin{aligned} A_{n-2} &= D_i k^{n-(n-2)} \\ B_{n-1} &= D_a k^{n-(n-1)} \\ A_{n-1} &= D_i k^{n-(n-1)} \\ B_n &= D_a k^{n-n} \end{aligned}$$

And

$$D_e = D_i (k^{n-1} + k^{n-3} + \dots + k^{n-(n-2)} + k^{n-(n-1)}) + D_a (k^{n-2} + k^{n-4} + \dots + k^{n-(n-2)} + 1)$$

or

$$D_e = D_i k (k^{n-2} + k^{n-4} + \dots + k^{n-(n-2)} + k^{n-n}) + D_a (k^{n-2} + k^{n-4} + \dots + k^{n-(n-2)} + 1) \quad (3)$$

The series in the parentheses of Equation (3) are geometrical, the first term is 1, the common factor is k^2 , and there are $n/2$ terms in each Thus

$$D_e = D_i k \left\{ \frac{1 - (k^2)^{n/2}}{1 - k^2} \right\} + D_a \left\{ \frac{1 - (k^2)^{n/2}}{1 - k^2} \right\}$$

or

$$D_e = \{D_i k + D_a\} \left\{ \frac{1 - k^n}{1 - k^2} \right\} \quad (n \text{ even}) \quad (4)$$

comes through Since 11 is odd, we use Equation (2)

$$D_e = D_i \left\{ \frac{1 - k^{n+1}}{1 - k^2} \right\} + k D_a \left\{ \frac{1 - k^{n-1}}{1 - k^2} \right\}$$

By means of Equation (11) the fraction of the dose that will be added to the effective dose on the thirteenth day may be determined

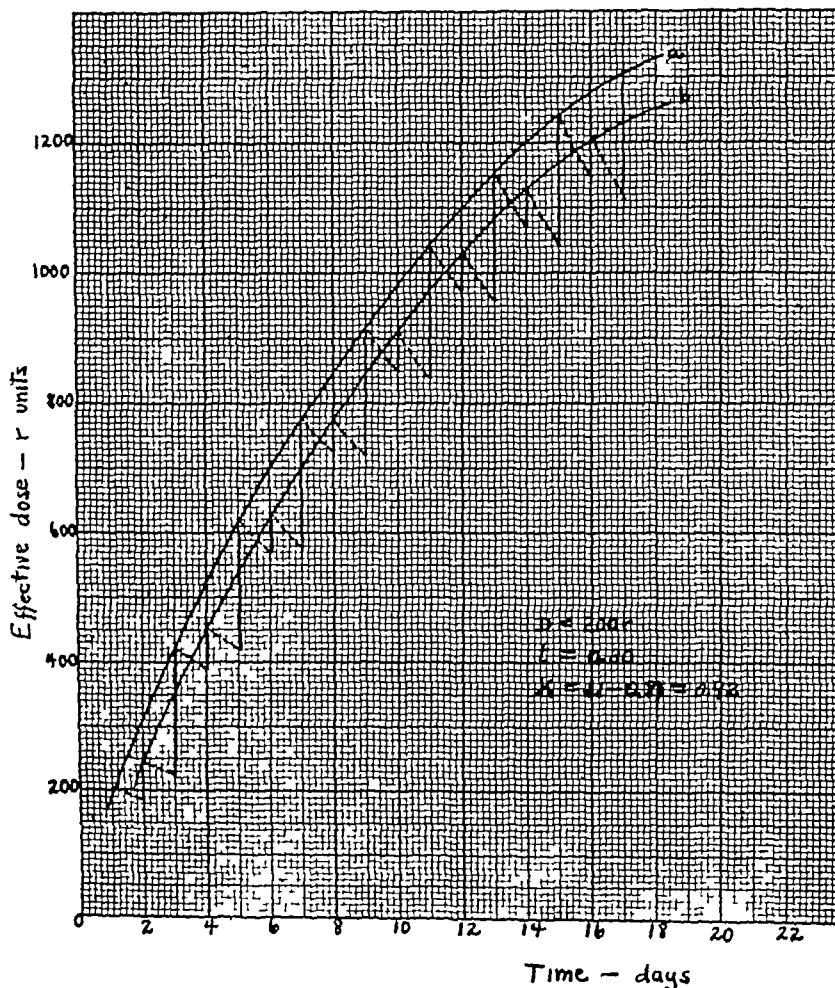


Fig 1

For roentgen radiation $\lambda_{er} = 0.16 \text{ \AA}$, $\beta = 0.077$ per day Hence $k = (1 - 0.077) = 0.923$ per day D_i , the initial dose, = 200 r, and D_a , the alternating dose, = 200 r $\times 0.3 = 60$ r Thus, substituting

$$c = k^n(k + t) = (0.923)^{11}(0.923 + 0.3) \\ = (0.412)(1.223) = 0.504$$

meaning that 50.4 per cent of the dose on the thirteenth day will be added to the effective dose, or $c(200 \text{ r}) = 0.504(200 \text{ r}) = 100.8 \text{ r}$ And the effective dose on the thirteenth day will be $1,038.8 \text{ r} + 100.8 \text{ r} = 1,138.8 \text{ r}$

Or we may find the time at which only 10 per cent of the daily dose is added toward the effective dose Using Equation (11.1),

$$D_e = 200 \text{ r} \left\{ \frac{1 - (0.923)^{11+1}}{1 - (0.923)^2} \right\} + (0.923)(60 \text{ r}) \left\{ \frac{1 - (0.923)^{11-1}}{1 - (0.923)^2} \right\} \\ = 200 \text{ r} \left(\frac{0.621}{0.149} \right) + 55.4 \text{ r} \left(\frac{55.4}{0.149} \right) = \\ 200 \text{ r} (4.17) + 55.4 \text{ r} (3.71) \\ = 1040 \text{ r (to within the error of slide rule reading)}$$

This gives the total effective dose on the n th day just after the dose has been administered, the dose D having been given every m th day for the n days

It is frequently desirable to know how long it will take a given method of dosage to reach the so-called equilibrium state. Theoretically this condition is never attained. There is, however, a condition attained in which the daily incremental dose contributes a negligibly small amount to the effective dose. For practical purposes this may be taken as the equilibrium condition. Consider the case described by Equation (9). The increment of effective dose is given by

$$(Dk^m + D) - D_e = cD \quad (0 < c < 1)$$

Substituting the value of D_e , we have

$$\left[D \left\{ \frac{1 - k^{n+m-1}}{1 - k^m} \right\} k^m + D \right] - D \left\{ \frac{1 - k^{n+m-1}}{1 - k^m} \right\} = cD$$

Dividing and multiplying by D and $(1 - k^m)$, respectively,

$$(1 - k^{n+m-1})k^m + 1 - k^m - 1 + k^{n+m-1} = c(1 - k^m)$$

$$k^{n+m-1} = c \quad (10)$$

$$n = \frac{\log c}{\log k} - (m - 1) \quad (10.1)$$

Since $0 < c < 1$ and $0 < k < 1$, it is evident that $\frac{\log c}{\log k}$ is always a positive number.

An important feature of Equation (10) is that for a given c , the value of n is independent of the daily incremental dose D , n depends primarily on k , and to a lesser extent on m .

Consider Equations (2) and (4). Let $D_e = D, t = tD$, where $0 < t < 1$. In the following discussion we have only to consider the case wherein $0 < t < 1$, for, when $t = 1$, we have the case taken up in Equations (9) and (10), and when $t > 1$, we have only to consider the last $(n - 1)$ terms of the dosage series since they will form a series in which $0 < t < 1$. The increment of effective dose for the time between successive odd numbered days expressed as a fraction of D is given by

$$[(Dk + tD)k + D] - D_e = cD$$

Substituting the value of D_e from Equation

(2) and clearing of fractions we arrive at the following

$$k^n(k + t) = c \quad (11)$$

$$n = \frac{\log c - \log(k + t)}{\log k} \quad (11.1)$$

Corresponding expressions for the interval between even numbered days will be found to be

$$k^n = \frac{ct}{k + t}$$

$$n = \frac{\log ct - \log(k + t)}{\log k}$$

The equations pertaining to the increment of effective dose that accrues in the interval between odd numbered days (11) and (11.1), are more important, as it will be seen from Figure 1 that the effective dose is generally at a maximum on odd numbered days. Figure 1 shows the typical behavior of effective dose when alternate doses are given. The dotted lines indicate the course of depreciation as the tissue recovers. Curves (a) and (b) are lines drawn through the values of the effective dose on odd numbered and on even numbered days, respectively.

It is to be observed that when alternating doses are given, the time required to reach a state of equilibrium is a function of the ratio of the doses, t , and of $(k + t)$.

APPLICATIONS

For those who are interested primarily in the practical applications of these equations rather than in the mathematical derivations the following examples are presented.

1. Suppose a tumor on the right side of the neck is to be treated with roentgen radiation, $\lambda_{eff} = 0.16 \text{ \AA}$. Two hundred r units are to be given the right side on the first day, the same amount to the left side the following day, etc., and thus alternated for 11 days. What will be the effective dose on the eleventh day after the dose has been administered on that day? Suppose the neck depreciates the primary beam 70 per cent, that is, 30 per cent

A STUDY OF BACK-SCATTER FOR SEVERAL QUALITIES OF ROENTGEN RAYS¹

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It is a well-known fact that when a beam of radiation strikes matter, some of the rays are scattered in all directions. The amount of scatter depends upon the quality of the radiation, the nature of the material upon which it impinges, the volume of the material, and the area of the beam. The relative amount of scattered radiation is different in different di-

rections, being greatest in the forward and least in the backward direction. The portion scattered backward is of particular interest in radiation therapy, because of its contribution to the dose delivered at the surface of the body. This dose consists, in part, of radiation from the primary beam, and, in part, of that scattered back by the underlying tissues. Since all depth doses are determined in relation to the surface dose, it is necessary to know this accurately. Moreover, it is

not possible to determine the erythema dose in terms of physical units (roentgens) until the intensity of a beam as measured in air can be related to that on the surface of the body. Many attempts have been made to measure the back-scatter experimentally, by means of ionization chambers, photographic films, biological media, etc., placed

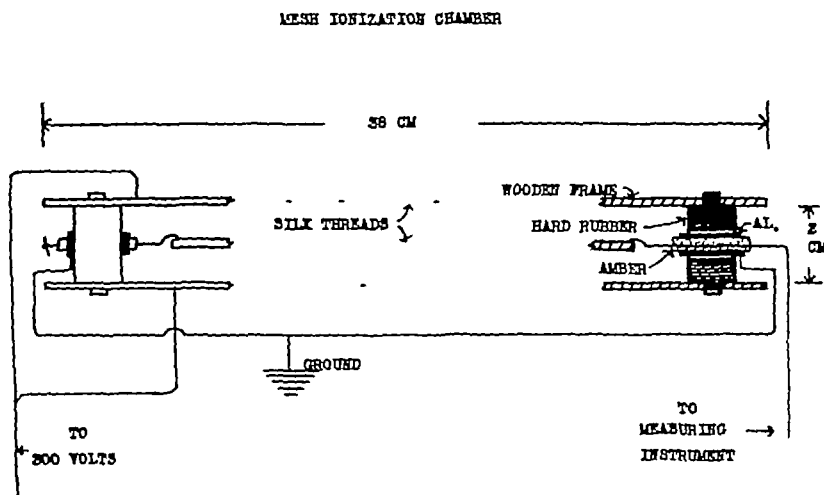


Fig. 1 Special ionization chamber with electrodes consisting of three layers of very fine gauze impregnated with India ink.

rections, being greatest in the forward and least in the backward direction.

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upon the surfaces of water, paraffin, and the human body itself. The results obtained have disagreed widely. Most of the differences may be explained by variations in experimental conditions. This is particularly true in the case of physical measurements, in which instance the nature and material of the ionization chamber are extremely important. When approximately the same experimental conditions are used, there is fair agreement in the results obtained. The method of choice so far has been the use of the small ionization chamber of organic materials, the assump-

¹ Presented at the Fourth International Congress of Radiology Zürich 1934.

$$n = \frac{\log c - \log(k + 1)}{\log k} = \frac{\log 0.1 - \log(0.923 + 0.3)}{\log 0.3}$$

$$= \frac{-1 - (0.08743)}{-0.0348} = \frac{1.08743}{0.0348} = 31.2 \text{ or } 31 \text{ days}$$

meaning that on the thirty-third day only 10 per cent of the 200 r will be added toward the effective dose

2 Suppose that radium radiation filtered through 1 mm of platinum is given in doses of 3,000 mg-hr every second day. What will be the effective dose after 21 days, and what percentage of the dose will be added to the effective dose on the twenty-third day? The effective dose is given by Equation (9)

$$D_e = D \left\{ \frac{1 - k^{n+m-1}}{1 - k^m} \right\}$$

$D = 3,000 \text{ mg-hr}$, $\beta = 0.04 \text{ per day}$, hence $k = (1 - 0.04) = 0.96$, $m = 2$, $n = 21$

$$D_e = 3,000 \left\{ \frac{1 - (0.96)^{21+2-1}}{1 - (0.96)^2} \right\} = 3,000 \left(\frac{0.59}{0.078} \right)$$

$$= 22,680 \text{ mg-hr}$$

Equation (10) enables us to find c ,

$$\frac{k^{n+m-1}}{(0.96)^{21+2-1}} = c = (0.96)^{22} = 0.4099 = 0.41$$

Thus 41 per cent of the dose, or 1,230 mg-hr, will be added to the effective dose of the twenty-first day to give the effective dose of the twenty-third day (22,680 + 1,230 = 23,910 mg-hr). Conversely, we may find the time at which only 10 per cent of the daily dose will be added to the effective dose. Using Equation (10.1),

$$n = \frac{\log c}{\log k} - (m - 1) = \frac{\log 0.1}{\log 0.96} - (2 - 1)$$

$$= \frac{-1}{-0.0177} - 1 = 56.5 - 1 = 55^+ \text{ days}$$

meaning that on the fifty-seventh day only 10 per cent of the daily dose will be added toward the effective dose

SUMMARY

1 A general expression is derived for the effective dose after n days, the dosage consisting of two doses that alternate from day to day. Equations (2) and (4)

2 The alternating doses are made equal to one another. The resulting expression gives the effective dose when the same dose is given for n days. This is then generalized to the case wherein the same dose is given every m th day for n days. Equation (9)

3 It is then shown that the time required for a given method of dosage (using a single dose of the same value each time) to reach an approximate state of equilibrium is independent of the daily dose. Equation (10)

4 When, however, two different doses alternate from day to day, it is found that the time required for the attainment of the equilibrium state is dependent on the ratio of the two doses. Equations (11) and (11.1)

5 Practical applications of the formulae are given

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lard circuit The size of the beam reaching the chamber was regulated by three lead diaphragms, one in the tube holder were properly centered at all times As mentioned above, the third collimating diaphragm was 152 cm from the target

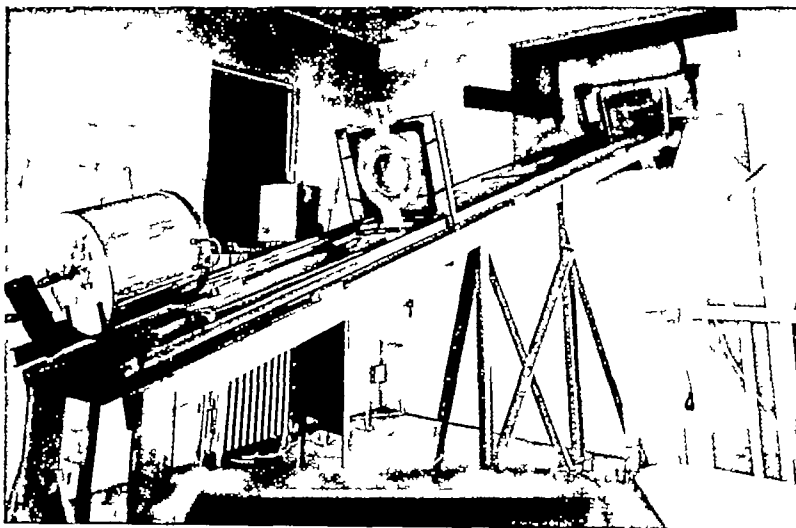


Fig 3 Photograph of apparatus for studying back-scatter with x-rays

and two outside it, their distances from the target being 46, 86, and 152 cm, respectively For the measurement of the primary radiation, the diaphragm shown behind the chamber, and the scattering unit were removed This scattering unit consists of an aluminum pot 30 cm deep and 35 cm in diameter, lined with 3 mm of lead and then filled with paraffin The purpose of the lead is to prevent radiation scattered by the paraffin from emerging, striking the walls, and giving rise to disturbing radiation When this scattering mass was placed behind the chamber, radiation scattered backward was registered in the ionization current The diaphragm between the paraffin and the chamber was placed there in order to stop rays scattered obliquely backward out of the beam, since it was desired to measure only radiation scattered back within the irradiated area The opening in this diaphragm was slightly larger than the actual beam

The actual set-up is shown in Figure 3 Diaphragms, chamber, and scattering element were mounted on rails so that they

The ionization chamber was either 300 or 450 cm from the target The various filters used were placed in the first diaphragm, which is in the tube holder For the 300 cm distance, the scattering element could be rolled 200 cm farther back on the rails, when no effect could be detected from it For the 450 cm distance it was necessary to remove the pot from the runway The primary beam was never large enough to strike the wooden framework of the runway within 200 cm of the chamber Walls, floor, and ceiling were always more than 200 cm from the chamber, except at the 450 cm distance, when the floor was only 150 centimeters The rear wall, the only one which could be struck by the primary beam, was always at least 300 cm away

The centering of the beam with regard to diaphragms and chambers was always checked photographically A film placed just in front of the chamber, and another just behind the rear diaphragm, showed accurately the size and shape of the beam and the clearance of the rear diaphragm

With large beams it was not possible to

tion being that its walls have no effect on the results. Some of these chambers, when calibrated against a standard open aluminum tube is inserted, fitted tightly into each of these tubes is an amber insulator. Through the center of each of the

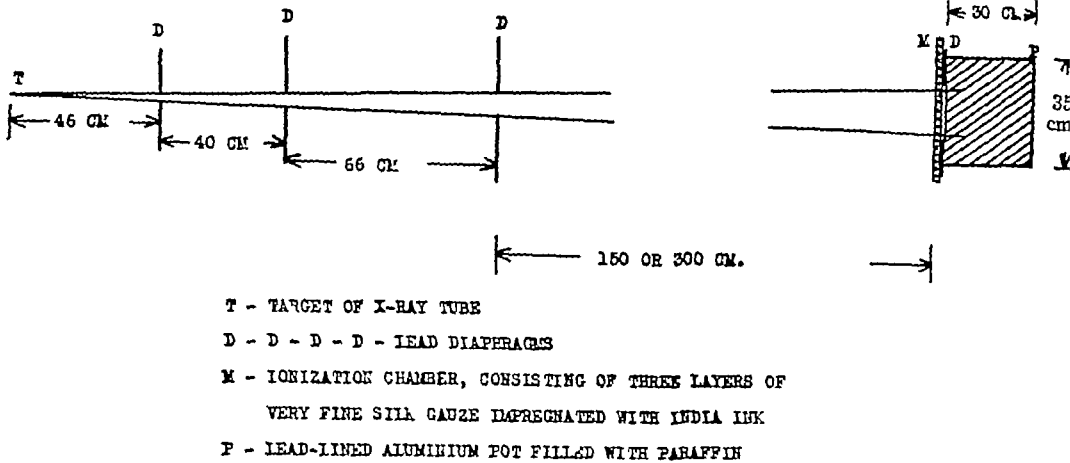


Fig 2 Diagram of set-up for studying back scatter from paraffin with X rays

air chamber, agree with it over a wide range of quality of radiation. However, the scattered radiation contains components of very long wave length, which may be more or less completely absorbed in the walls of the chamber. At the same time, the secondary radiation from these walls and from the inner electrode may introduce a disturbing factor.

The observations here reported were made with a new type of ionization chamber, which is shown diagrammatically in Figure 1. This consists of three parallel plates, about 40 cm square, of which the two outer ones are made of very fine silk net, impregnated with India ink, while the inner is of fine silk threads, similarly treated, stretched 1 cm apart. The net, when inked and ready for use, weighs 14 mg per 100 sq cm, this is about one-third the weight of cellophane. The frame for each plate is a square of four strips of very light wood, 1 cm wide and 2.5 mm thick, painted with India ink. The two outer ones are maintained 2 cm apart by plugs of hard rubber at the four corners, and are charged to 300 volts by dry batteries. Through each of these rubber plugs, as shown in the diagram, a small

insulator passes a fine copper wire, which is connected to one corner of the frame carrying the threads which form the inner plate. These wires form the support of this plate, and one of them serves as the lead to the measuring instrument. The four aluminum shields of the amber insulators are grounded, thus furnishing an effective guard ring. The chamber is held in the path of the beam of radiation by means of clips of hard rubber which hold the wooden frame and are attached to a firm support. No part of the wooden frame or any of the outside support ever comes into the path of the beam.

All ionization measurements were made with the vacuum tube instrument of Failla. This has an extremely wide range of sensitivity, and is much faster than any electroscope or electrometer. It is, therefore, possible to make many readings in the course of an experimental run, even when the intensities of the radiations are low, thus permitting careful checking of results.

The general arrangement of the apparatus is shown diagrammatically in Figure 2. X-rays were generated at voltages from 80 to 185 K V peak by a simple Vil-

reading with the diaphragm alone. This value for the scattered radiation, divided by the value for the primary beam, gives

higher than most of those reported in the literature as having been measured with small, so-called "air wall" chambers. The

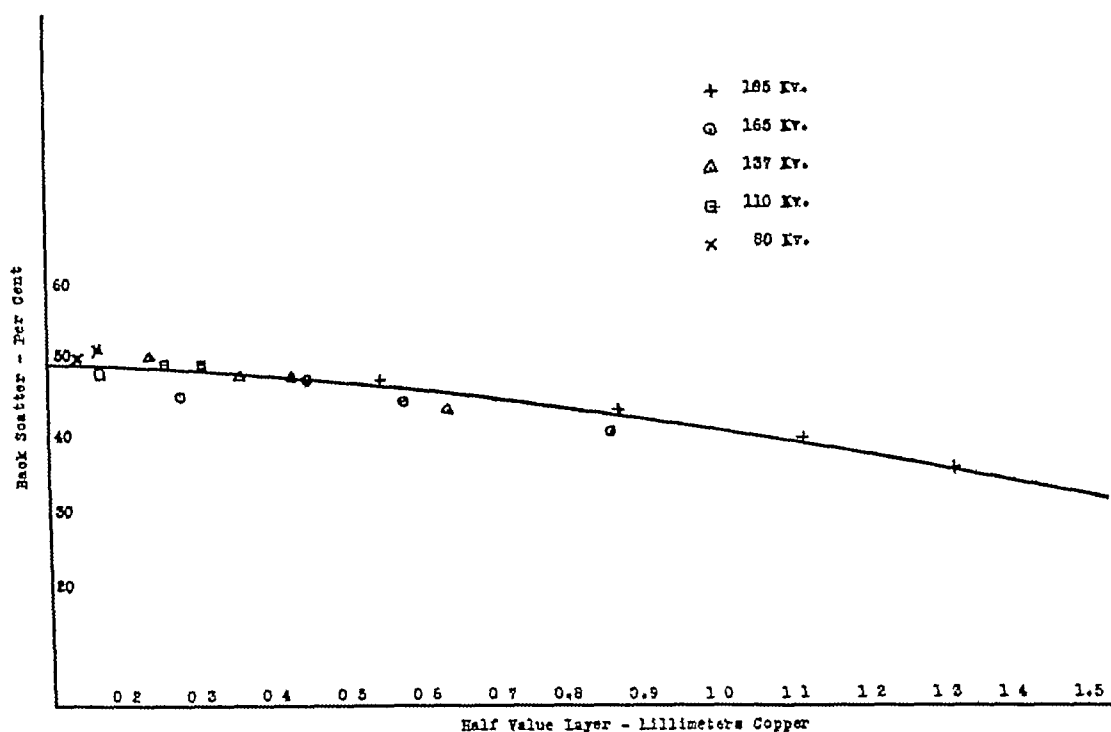


Fig 5 Curve showing percentage back-scatter in a 78 sq cm field, for x rays over a wide range of quality

the percentage of back-scatter. If the primary beam be called 100 per cent in each case, the percentage value for the total radiation will be 100 plus the back-scatter percentage.

For each distance of the chamber, curves were drawn showing the relation of back-scatter to size of field, for the four qualities of radiation tested. For a given field, the values at the two distances were found to agree as well as two sets of values at the same distance. The data were, therefore, all combined, and the distance considered immaterial, provided it was great enough so that scattered radiation passing back through the chamber did not strike the diaphragms and give rise to a second scattered beam, which might return to the chamber.

The results of this series of experiments are presented in Table I. The values obtained for back-scatter are considerably

amount of scatter increases steadily with size of field and with decrease in half value layer.

TABLE I—TOTAL RADIATION INCLUDING BACK-SCATTER FROM PARAFFIN

185 K V Peak (Kenetron Rectification)
Various Filters and Fields

Area of Beam	Filter—mm Copper			
	0 16	0 48	1 03	2 06
Sq cm	Half Value Layer—mm Copper			
	0 55	0 87	1 12	1 34
Total Radiation—Per Cent (Primary Beam = 100 Per Cent)				
50	143	140	136	132
75	148	144	140	136
100	154	150	146	142
150	160	156	152	148
200	166	162	158	154
300	176	172	167	162
400	182	178	175	171

The effect of variation of radiation with variation in field or in filter may be considered independently. The effect on the

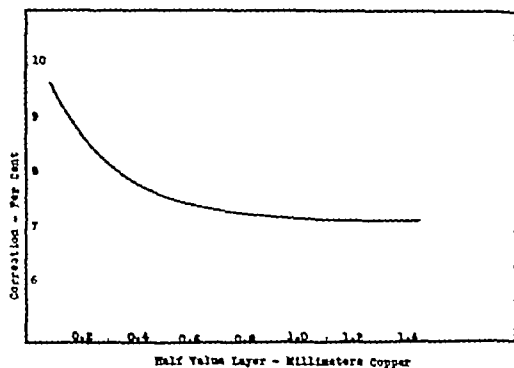


Fig 4 Curve showing correction for space between paraffin scattering element and ionization chamber

eliminate entirely the stem radiation, even with the three diaphragms. This showed as a very slight haze on one side of the test film. Such radiation, being outside the beam which passed through the aperture of the rear diaphragm, would strike this lead and send scattered radiation of its own into the chamber. This proved never to be more than a few per cent of the total scatter, but was measured for every diaphragm and every quality of radiation, so that the proper correction could be made.

There was a possibility that scattered radiation striking the edges of the lead diaphragm might give rise to secondary rays of the electron type, which would increase the ionization supposedly due to scattered rays from the paraffin. In order to eliminate this, the diaphragms were coated with a celluloid solution to a distance of 2 cm from the aperture, on both sides. This made no difference in the readings, showing that such radiation did not occur in sufficient quantity to be considered.

Between the surface of the paraffin and the surface of the chamber was an air space of 1 cm, the lead diaphragm being in contact with the paraffin. In this air, some of the softest scattered and secondary rays were absorbed. The method of correcting for this was as follows. After the routine measurements with and without diaphragm and paraffin had been made, the paraffin was moved back from the

chamber, a short distance at a time, a reading being taken for each position. A curve was then drawn showing decrease in radiation with increase in distance, and this was extrapolated back to the position of the surface of the chamber. Since the rate of change in intensity was not large, and the distance covered by the extrapolation only 1 cm, such a method of correction is legitimate. This extrapolated value was used as the correct reading for the total radiation, including back-scatter. The correction was never large, and was independent of the field, within the limits investigated. It varied somewhat with the quality of the radiation, as shown in Figure 4.

Measurements of scattered radiation were first made at 185 K V peak, with filters of 0.16, 0.48, 1.03, and 2.06 mm of copper, corresponding to half value layers in copper of 0.55, 0.87, 1.12, and 1.34 mm, for a range of fields from 50 to 400 sq cm, at each of the two distances for the ionization chamber. All of these experiments were repeated at least four times, the data presented being the average of these results.

For the calculation of the percentage back-scatter for any particular case, the procedure was as follows. Four readings were taken, (1) with the diaphragm completely closed, to obtain a correction for stray radiation and for the natural leak of the chamber, (2) with the proper filter in the diaphragm, with the ionization chamber in position, but without rear diaphragm or scattering unit, to obtain the value for the primary beam, (3) with the rear diaphragm in place, to obtain a correction for radiation scattered from it, which might otherwise be included in the scatter from the paraffin, (4) with the paraffin in place, to obtain the total radiation including back-scatter. All readings were corrected for the leak and stray radiation. The reading with paraffin was corrected for the air space between it and the chamber. The scattered radiation was taken as the difference between this corrected reading for the paraffin and the

reading with the diaphragm alone. This value for the scattered radiation, divided by the value for the primary beam, gives higher than most of those reported in the literature as having been measured with small, so-called "air wall" chambers. The

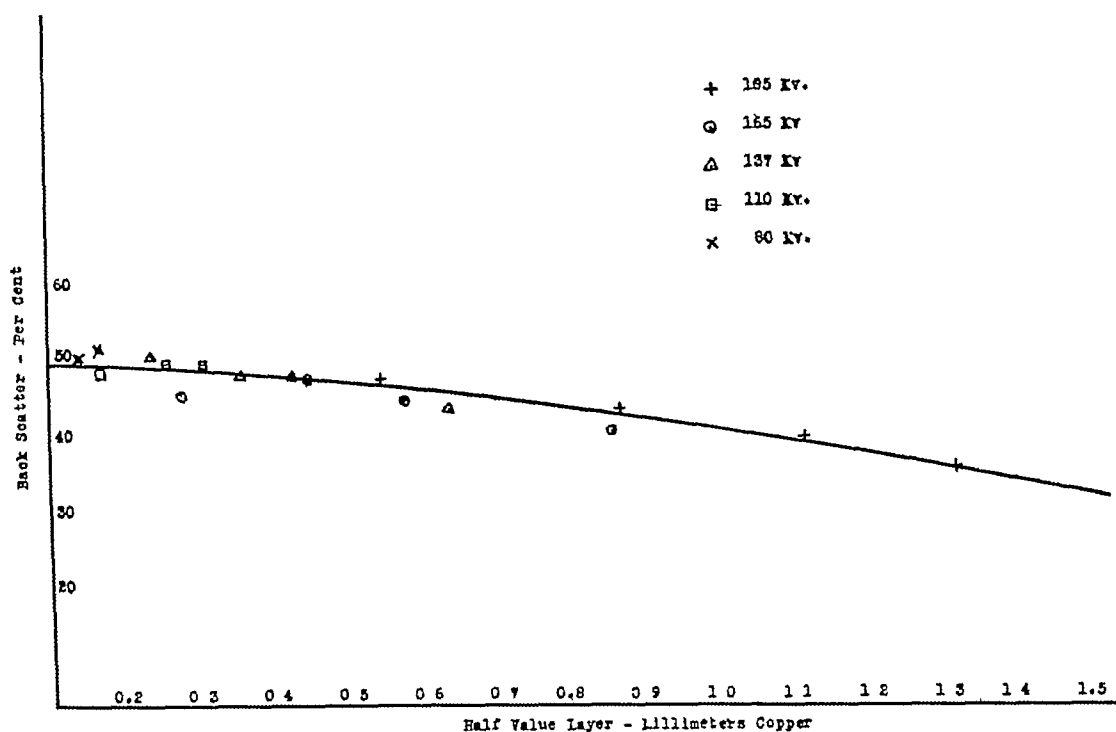


Fig 5 Curve showing percentage back-scatter in a 78 sq. cm. field, for x-rays over a wide range of quality

the percentage of back-scatter. If the primary beam be called 100 per cent in each case, the percentage value for the total radiation will be 100 plus the back-scatter percentage.

For each distance of the chamber, curves were drawn showing the relation of back-scatter to size of field, for the four qualities of radiation tested. For a given field, the values at the two distances were found to agree as well as two sets of values at the same distance. The data were, therefore, all combined, and the distance considered immaterial, provided it was great enough so that scattered radiation passing back through the chamber did not strike the diaphragms and give rise to a second scattered beam, which might return to the chamber.

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185 K V Peak (Kenetron Rectification)
Various Filters and Fields

Area of Beam	Filter—mm. Copper			
	0.16	0.48	1.03	2.06
	Half Value Layer—mm. Copper			
	0.55	0.87	1.12	1.34
Sq. cm.	Total Radiation—Per Cent (Primary Beam = 100 Per Cent)			
50	143	140	136	132
75	148	144	140	136
100	154	150	146	142
150	160	156	152	148
200	166	162	158	154
300	176	172	167	162
400	182	178	175	171

The effect of variation of radiation with variation in field or in filter may be considered independently. The effect on the

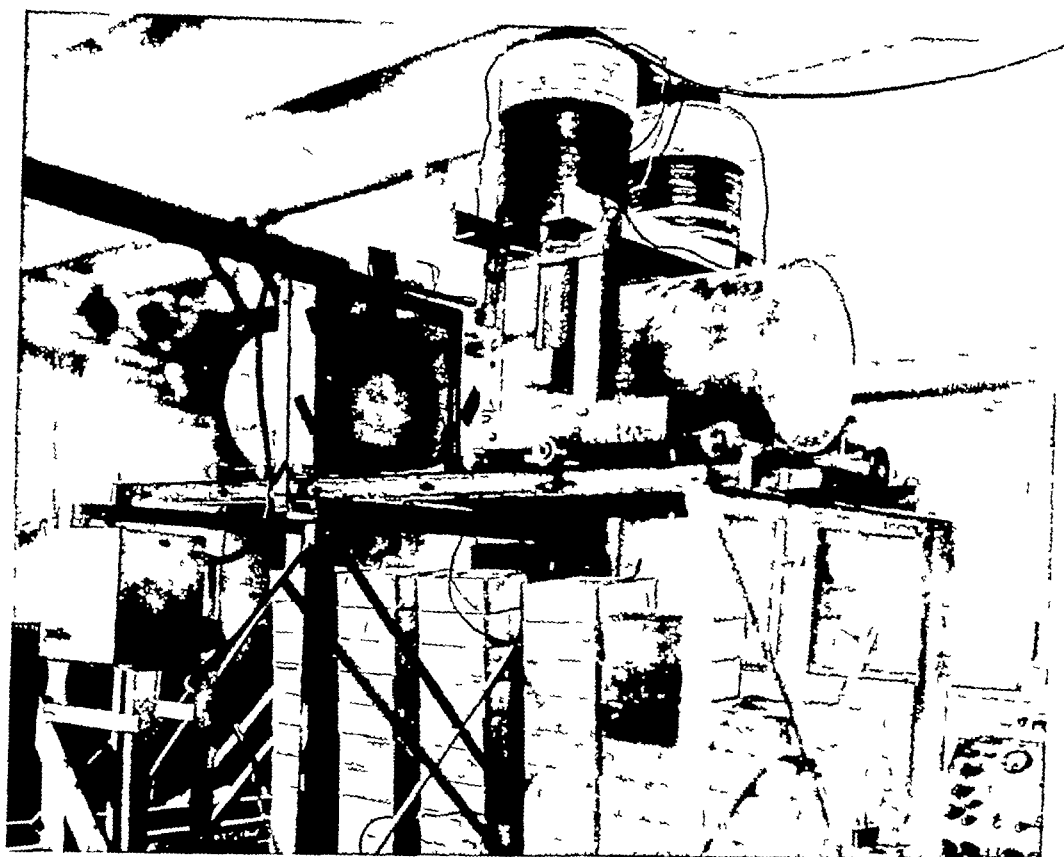


Fig 6 Photograph of apparatus for studying back-scatter with gamma rays

total radiation of change in quality of the beam, for any given field, may be investigated by setting the value for some one particular quality as 100 per cent, and expressing the others in terms of it. This is done in Table II for each field, the value for the 0.48 mm copper filter being taken as 100 per cent in every case. From this table it is evident that the change in relative total radiation with change in quality is independent of the field.

In a similar way the variation with field may be studied for each quality. In Table III, the value for the 100 square centimeter field is set as 100 per cent, for each quality of radiation. It is seen that the change in intensity of radiation is independent of the quality.

The entire range of quality considered thus far is not great. A single voltage setting on the x-ray machine was used,

TABLE II—VARIATION IN TOTAL RADIATION (INCLUDING BACK-SCATTER) WITH QUALITY FOR FIELDS OF DIFFERENT SIZES
185 K V Peak (Kenetron Rectification)

Area of Beam	Filter—mm Copper			
	0.16	0.48	1.03	2.06
	Half Value Layer—mm Copper			
Sq cm	0.55	0.87	1.12	1.34
Total Radiation—Per Cent				
50	102	100	97	94
75	103	100	97	94
100	103	100	97	95
150	103	100	97	95
200	102	100	97	95
300	102	100	97	94
400	102	100	98	95

and the quality varied by changing filters. It was, however, desirable to carry the study through a much greater range of quality. This was done for a field of 78 sq cm (a 10 cm circle) for various voltages and filters, giving a complete range of

half value layers from 1.34 to 0.12 mm of copper. This was the minimum which could be obtained with the x-ray machine available, using 80 K V and no filter. The actual beams used are specified in Table IV.

TABLE III—VARIATION IN TOTAL RADIATION (INCLUDING BACK-SCATTER) WITH FIELD FOR DIFFERENT QUALITIES OF RADIATION

185 K V Peak (Kenetron Rectification)

Area of Beam	Filter—mm Copper			
	0.16	0.48	1.03	2.06
Sq cm	Half Value Layer—mm Copper			
	0.55	0.87	1.12	1.34
Total Radiation—Per Cent				
50	93	93	93	93
75	96	90	90	96
100	100	100	100	100
150	104	104	104	104
200	108	108	108	108
300	114	115	114	114
400	118	118	119	120

TABLE IV—SPECIFICATIONS OF RADIATIONS USED FOR WIDE RANGE IN QUALITY

K V Peak	Filter	Half Value Layer
	Mm Cu	Mm Cu
185	2.06	1.34
	1.03	1.12
	0.48	0.87
	0.16	0.55
165	0.64	0.86
	0.32	0.58
	0.16	0.45
	0	0.28
137	0.64	0.64
	0.32	0.43
	0.16	0.36
	0	0.24
110	0.32	0.31
	0.16	0.26
	0	0.17
80	0.16	0.17
	0	0.12

It is evident that any given part of the quality range may be obtained by using two or three different voltages with the appropriate filters. In other words, there is overlapping in quality ranges obtained with the various voltages.

The values for back-scatter obtained with these various beams are shown in Figure 5, where they are plotted in relation to quality as expressed by half value

layer in copper. Each point is the average of observations made in at least three different series. The percentage back-scatter for a given average quality of radiation is seen to be independent of the voltage, within the range of experimental error.

At the other extreme of penetration of radiation available, some measurements have been made with gamma rays. The experimental set-up is shown in Figure 6. The radon source, 300 to 500 mc, filtered by 2 mm of brass, was placed within a large pot of lead, so that there were at least 15 cm of lead toward the back and sides and 20 cm toward the front, except for the cone through which the rays emerged. This was of such a size that the beam on emerging was 2.5 cm in diameter, and at a distance of one meter, 15 cm in diameter. Immediately upon issuing from the lead pot, the beam passed between the poles of an electromagnet, which could be used to remove the secondary beta rays.

The long range secondary beta rays liberated in the air by the gamma rays introduce serious complications, and for this reason some other approach will have to be found to this part of the problem. The back-scatter for gamma rays obtained with the method described above appears to be also higher than that obtained with the usual small chambers, but no corrections for the secondary beta ray effect just mentioned can be made at present.

A practical application of accurate measurements of back-scatter would be the specification of the number of roentgens delivered to the skin when the intensity of the beam in air is known. A statement of radiation dose in terms of the amount delivered to the tissues would be preferable to a statement of the quantity as measured in air. Present methods of measuring by means of a small ionization chamber placed on the skin are unsatisfactory because, as stated earlier in this paper, the wall effects of such chambers are unknown for the very soft scattered and secondary radiations. Before the data here given can be applied directly to

a statement of dosage, it will be necessary to test experimentally some of the values for threshold erythema doses obtained therefrom. This work is under way, and it is hoped that a report on the subject can be made soon.

SUMMARY

The back-scatter from paraffin has been measured, for a large range of fields and qualities of radiation, by a new method.

Values of percentage scatter obtained in this way are considerably higher than those obtained with so-called "air wall" ionization chambers. The scatter in-

creases with the irradiated area and with the effective wave length of the radiation, the two effects being independent of each other.

Tables are given for the total radiation, including back-scatter, for a range of fields and qualities, for the variation in total radiation with field for any quality, and for the variation with quality for any field.

The authors wish to express their indebtedness to Dr G Failla, for his assistance in devising the experimental set-up, and for his constant interest and advice throughout the course of the work.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE QUALIFIED SPECIALIST

In the field of medicine, groups of specialists have set machinery in motion for awarding certificates of merit to those of their number who are justly entitled to so style themselves. One of the purposes back of the movement, and the most important one in the minds of many, is to enable the specialty and those awarded certificates of qualification to maintain standing and prestige. Perhaps entirely too much is expected in that regard, particularly in view of the qualifying procedures generally adopted.

In a general way, a specialty may be defined as the application of extraordinary knowledge to a part of a large general field. In certifying to the qualifications of specialists under such a definition, enquiry is restricted very largely to the matter of "extraordinary knowledge" which under the circumstances may possibly be the only practical procedure. However, the fact should not be lost sight of that a specialty may lose caste through the operation of other factors for which the specialist may be no less accountable than he is for knowledge of his subject. As a matter of fact, loss of caste is not nearly so apt to occur through the specialist's ignorance as it is *from his failure to integrate his special knowledge with the general knowledge of the entire field of which his particular department represents a comparatively small part*. It is only by such integration that the "specialist," as understood in the definition, is clearly differentiated from the skilled workman or technician. Mere knowledge has comparatively little to do with it. Failing to secure such integration, he becomes an "assistant," and no amount of "qualifying" or "labeling" or "resolving" can change his status one iota. Such a situation is in the main responsible for the unenviable position in which some of the medical specialties now find themselves.

The medical profession as a whole is menaced by a somewhat analogous threat as regards its status. In writings on the subject we find over and over again the statement that "it is the personal relationship between physician and patient which keeps medicine a profession," a statement which is undoubtedly true. By

exactly the same token, it is the personal relationship between the medical specialist and patient that keeps the specialist a respectable and respected member of that profession. Some of the specialties do not consistently maintain that relationship, and to just that extent forfeit the esteem which they mustakenly regard as an inherent right.

The practical implications of these fundamental facts should be at once apparent to the radiologist. If he is to maintain a high standing in the medical profession and in the community, he must establish a personal relationship with every patient who comes or is referred to him. In the first place, it enables him to render infinitely better service to the patient, which, apart from other considerations, is ample justification for adopting it as a routine practice. Without in any way interfering with the rights and prerogatives of others, it will enable him to build up a clientele of his own which will in the end be essential to his survival as a specialist. His colleagues in other fields will continue to refer patients to him but with the added incentive that if he doesn't they will in the course of events likely go to him anyway. Ultimately he will find himself referring about as many patients to other physicians as they refer to him and his destinies will then come to be indissolubly linked with those of the profession as a whole. Then, and not until then (assuming that he has the requisite knowledge), can it be proclaimed without fear of successful contradiction, "He is a qualified specialist."

THOMAS A. GROOVER, M.D.

SHOULD THE PATIENT BE TOLD?

Those of us who are confronted with the problem of the care and treatment of patients who have malignant disease are often in a quandary as to whether or not the patient should be told of his true condition. Too frequently, relatives come to us and say, "Under no circumstances must you tell her that she has cancer, she would commit suicide." Some-

times the family physician who has been treating the patient for an ulcer of the cervix for months will refer her for treatment with the request that she be not told that a carcinoma exists. The patient has probably repeatedly asked him if she has cancer and has been emphatically informed that there is none present, even in view of the fact that no biopsy has been done to verify or refute the statement. The consultant is really "put on the spot" at such times. He must decide whether to defer to the wishes of the patient or to those of the relatives or a fellow-practitioner who has been remiss in his duties to the patient in not taking all precautions for making an early diagnosis by modern methods. A little "white lying" on the part of the consultant at times may be justifiable when the patient is moribund, but when such a condition as carcinoma exists which not only necessitates radical surgical treatment or adequate radiation therapy and in which frequent follow-up examinations are necessary for further treatment or statistical study, it requires co-operation on the part of the patient, thus necessitates telling what the condition actually is.

Imagine trying to treat a patient with diabetes, nephritis, or cardiac decompensation without telling him what he has, still, all are incurable according to a strict interpretation, but are controllable by diet, medication, and rest if the patient understands and co-operates. The profession never did get very far in its fight against tuberculosis as long as the patient was told, "You have weak lungs," or "You are in a decline," or "You have a chronic bronchitis." On the other hand, when the patient was informed that he had pulmonary tuberculosis which required isolation to keep him from infecting the rest of the family or his friends, and that sanatorium treatment with bed rest was absolutely necessary, then we began to control tuberculosis. The patient had to know and help in the battle.

The same thing applies to cancer. Many doctors seem to fear telling patients that they have carcinoma. Why this is so, is difficult to explain. When we begin to tell patients what they have instead of hiding behind some fantastic explanation of symptoms at the request of others, then will we get co-operation. We must educate not only the patient but the entire family to the fact that because a malignancy exists the patient need not consider himself to be a social outcast. Undoubtedly, the

relatives are altruistic in their request for secrecy but sooner or later some "kind neighbor" will break the news if the physician does not. If confidence is to be mutual on the part of the patient and physician, then it is better that the true situation be told. In some patients the reaction might be severe at first as a few become hysterical, but in a day or two their morale will be back and co-operation will be established. Furthermore, we must not forget that these same children of the patient under consideration who have requested secrecy will some time reach the "cancer age." They will demand the truth that was withheld from their parents.

If the campaign against cancer is to be successful, it will require that the laity and the profession work together. Patients come with a straightforward story to the physician and, after a careful examination, expect a frank opinion. This examination should be thorough and, whenever possible, the opinion should be fortified by microscopic confirmation. The patient may not believe that carcinoma exists and may seek other advice, but at least the consultant will have done his duty in arriving at a correct opinion and advising suitable scientific treatment.

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1407 South Hope St.
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The Editor wishes to learn the views on this problem held by the readers of Dr. Meland's Editorial, and contemplates the publication of further communications if such are sent to him.

A brief symposium on the subject may develop.

COMMUNICATIONS

A HELPFUL SUGGESTION

Perhaps it may interest some of the older members of the Society to know that normal salt solution, used as a wet dressing, has proved beneficial in one case of very stubborn inflammatory hyper-keratosis from long use of x-rays. For a great many years I have used ointments and lotions of many types and formulae, but only within the last year have I resorted to sea water and normal salt solution, and I believe it is worthy of a trial. In my own case, I frequently go to sleep with a pair of

cotton gloves on my hands, with a little extra padding over the back of the hands and fingers, soaked with either sea water or normal saline solution. Occasionally, in between times, a little bland jelly with a lanolin base is used.

ALBERT SOILAND, M D

A REQUEST FROM DR JOSEPH C BLOODGOOD

Will any physician reading this who has a living case of giant-cell tumor for which nothing has been done, or for which there has been only irradiation five years ago, report the case, stating (a) the location of the tumor, (b) function at the time treatment began, and (c) function now. Also, give the name and address of the physician who reports the case, and the patient's name. The patient must be living, it must be at least five years since the beginning of treatment, there must have been a roentgen-ray diagnosis, with or without biopsy, and there must have been no treatment except irradiation.

Information is to be sent to Joseph C Bloodgood, M D, 3301 North Charles St, Baltimore, Md.

DR STANLEY MELVILLE

Because of the deaths of several of our pioneer radiologists, the medical world was made to see the dangers of the practice of roentgenology. In England, in 1921, a special committee was formed for the purpose of advising on these dangers. Dr Stanley Melville played a very prominent part in this action.

To this committee on x-ray and radium protection goes the credit for being the first in the work to draw up recommendations for safeguarding workers in this field. So valuable was their work that in 1928, the international Radiological Congress, at Stockholm, adopted their constructive ideas as a basis for their recommendations.

Dr Stanley Melville, one of the foremost pioneer radiologists, took a most important but unobtrusive part in all that concerned medical radiology. He featured prominently in the establishment of the Diploma in Medical Radiology and Electrology (D M R E) at Cambridge, in 1919, and subsequently the teaching and examinations connected with it were his constant care. The Bi-Lingual Congress of 1922 and the First International Congress of Radiology in London, in 1925, were

largely due to his initiative, as also was the formation of the British Institute of Radiology with which the Roentgen Society was eventually incorporated. His untiring energy led him to do much for the welfare of the lay worker, taking a prominent part in the foundation of the Society of Radiographers. Notwithstanding the fact that he was sadly handicapped physically, often suffering as the result of dermatitis incurred in the early days, Melville never spared himself when any work in the field of medical radiology had to be done, to be ever ready to step into the breach seemed a natural course of events.

The following eminent British radiologists are members of a committee to consider a memorial to perpetuate the name of Stanley Melville, such as a traveling fellowship in radiology or some other form of acknowledgment yet to be determined: Humphry Rolleston, Rutherford L S T Burrell, G W C Kaye, G W Mitchell, R S Paterson, Leo A Rowden, Sidney Russ, J Duncan White, and A E Barclay.

PROFESSOR PASQUALE TANDOJA IN MEMORIAM

Word has been received of the death of Professor Pasquale Tandoja, an esteemed experimenter and practitioner of radiology. Professor Tandoja has been for a number of years on the Foreign Advisory Staff of this Journal, and had many friends among radiologists in this country. Since the first International Congress of Radiology, in London, he had attended these gatherings, and many beside his fellow-countrymen will mourn his passing.

THE FIRST INTERNATIONAL CONGRESS OF ELECTRO- RADIOBIOLOGY

VENICE, SEPT 10 TO 15, 1934

The International Society of Radiobiology, established through the initiative and goodwill of a few people interested in radiobiological sciences and which has been for some time developing its activity through the keen work of its Secretary, Dr De Protti, of Venice, was constituted into an official body at the meeting of its first Congress, which took place in Venice during the month of September last.

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 HANS A JARRE M D, of Detroit
 E T LEDDY, M D, of Rochester, Minnesota

DAVIS H PARDOLL, M D, of Chicago
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Under the high Honorary Presidency of H E G Marconi, President of Accademia d'Italia (the Academy of Italy), H E Conte G Volpi di Misurata, State Minister, acting as Chairman, the Congress has carried out its works, which, owing both to the participation of famous scientists and to the importance of the subjects treated, proved of exceptional interest to all persons devoted to the study of physical, biological, and medical sciences. Among the many persons present at the meetings we should like to mention Prof Abderhalden and Prof Behnken as representatives for Germany, the Duca di Brogha and Prof Kopanwskı for France, Mr Arthur Compton (Nobel prize) and Dr Francis Carter Wood on behalf of the United States, Mr Adrian (Nobel prize), for England, Mr Marinescu representing Romania, Mr Baron and Mr Gurwitsch for Russia, and again for Italy H E E Fermi and H E Parravano, H E Rondoni, all Academicians of Italy, beside a large number of scientists belonging to various learned societies.

Reports of great scientific value were then made, among which I should like to mention as of great importance those by Mr Arthur Compton on "The Physical and Chemical Effects of Electrical Radiations", Dr F C Wood on "The Biological Effects of Ultra-sounds", Mr C Foà and Mr Adrian on "The Electrical Activity of the Nervous System", Signor Castaldi on "The Biological Effects of the Hertzian Waves", Mr Salowsky on "The High Frequency Oscillators". Remarkable reports were also submitted at subsequent meetings, among which were those by Mr Ornstein on "The Quantitative Methods of Spectrophotometry" and by Prof Abderhalden on "The Influence of Ultra-violet Rays on Proteaceous (?) Substances". Especially worthy of notice was the report by Prof Gurwitsch on "The Present Stage of the Mitogenetic Problem," following which Mr Marinescu's report dealt with

The Regeneration of Nerves as Related to Mitogenetic Radiation" and by Mr Rahn on "Micro organisms as Detectors of Mitogenetic Rays". Important communications were also made by Mrs Prof Brunetti on "Spectrography in Biology", by Mr E Regener on 'The Measuring of the Solar Ultra-violet Spectrum in the Stratosphere', by Prof

Hushkins on 'The Latest Progress of Genetic Radiation', by Prof Capelli on "The Biological Action of the Roentgen Rays on Cancerous Tissues", by Dr Wood on "The Roentgen Sensitivity of X-rays of Individuals Submitted to Ultra-violet Irradiation", by Sig Foà and Sig Galli on "The Biologic Effects of Secondary Radiations", by Mr Rivera on "Researches of the Radio action on Lower and Higher Vegetative Organisms", by Sig Santo-Ricci on "Measuring by Means of Absorbimetric Scales", by Mr Dobrovolskaja-Savadsckaja on "The Influence of X-rays on Heredity", by Sig Balli on "The Action of X-rays on the Cellular Elements", by Prof Behnken on "The Dosimetric Processes in Radiobiology", by Sig Pugno Vanoni on "Radio-roentgen Measurements". Special mention must also be made of the reports of Mr Donaggio on "The Action of X-rays on the Neurofibrillous Net", of Sig Palmieri on the "Radiobiotanalogic (?) Phenomena", of Prof Scholte on "The Action of X-rays on Nervous Tissue", of Sig Allodi on "The Radiology of the Fascia," and of Sig Rivera on the "Biologic Action of Metals".

At later meetings which were held at Padua University, Messrs Regener, Compton, Blackett, Rojji, and Fermi spoke on other subjects of interest in connection with the physics of x-rays.

The communications made in connection with the reports and dealing with similar subjects submitted to the attention of the Congress, were also numerous. Such communications amply proved that the greatest attention is being given to radiobiologic problems in every country and that the interest in such problems is ever on the increase. This appeared so evident at the closing of the activity of the Congress and to such a degree that the assembly deliberated, together with the final foundation of the International Society of Radiobiology, upon the institution of a permanent International Center of Radiobiologic Studies, with headquarters in Venice, of which the "Radiobiologic Review" is the official organ. The direction of the Society is still entrusted to Mr De Protti, and the next meeting of the Congress has been fixed for the year 1936.

MARIO PONZIO

Turin, Italy

Except in superficial cancers in which it is possible to destroy the growth by the caustic effect of radiation, the single massive dose method has been practically abandoned. Some type of fractional dose is now in general use. The "saturation method" of Pfahler consists of administering a large initial dose and maintaining the radiation effect at a maximum by giving a small daily dose until the total dosage is attained. The Coutard fractional dose method of applying the roentgen rays consists in giving a large total dose over a prolonged period (from 18 to 35 days), an equal amount being given daily until the total dose has been reached. Results have been obtained by this method which are superior to any previously thought possible. Holfelder has used a method that aims to take advantage of the large initial dose of the "saturation method" and subsequently to build up the dosage by the method of Coutard. The increased benefits from the fractionated dose method appear to arise from the improvement in the ratio between the destructive effect on the neoplasm and the reaction in the surrounding normal tissues.

Progress has also taken place in methods of radium therapy, especially in respect to interstitial radiation. The use of gold and platinum seeds was a great advance over glass seeds for the interstitial application of radon, the increased filtration lessens the danger of localized necrosis. The use of tubules or needles from 3 to 6 cm. in length with a very small amount of radon or radium element to the running centimeter in the form of a grid, has secured a fairly uniform dosage. Further advance may be made in roentgen apparatus by securing a much greater energy output by the use of tremendously higher milliamperage rather than by an increase in voltage.

Because of results obtained in large numbers of primarily inoperable and seemingly hopeless conditions and in recurrences after operation and because of improvements in results when used in addition to surgery the attitude toward radiation has radically changed during the past three or four years. Cancers of the skin have been treated by radiation methods almost from the time of the discovery of the roentgen ray. The basal-cell type when it is small and does not involve cartilage or other important structures is readily curable. The fractionated method of Coutard constitutes an epochal advance in dealing with lesions involving cartilage. The primary treatment of squamous-cell epithelioma should be a thorough irradiation of the entire lymphatic drainage area by the fractional method. The added danger of dissemination must be weighed when biopsy is contemplated, it should be postponed until about two weeks after roentgen irradiation to lessen the liability of spread. If there is any residuum of the primary lesion it can be destroyed by electrocoagulation or by implanting interstitially gold or platinum radon seeds or small needles of radium element. If excision is to be done at all, it should always be preceded by irradiation.

C. G. SUTHERLAND, M.D.

Treatment of Cancer of the Breast George W. Grier Pennsylvania Med Jour, October, 1934, 38, 19-23

The author discusses the treatment of cancer of the breast under the following subtitles: radiation without operation, pre-operative radiation, post-operative radiation, and treatment of recurrences.

It was formerly believed that radiation without operation should be confined to those cases of cancer of the breast which have been declared inoperable. Sir Berkeley Moynihan stated that he had abandoned surgery for radiation in breast cancer. However, the author believes that operable cases should have the benefit of surgery, as this procedure removes large masses of tumor tissue rapidly, saves much unnecessary radiation, and is followed by a sufficiently great percentage of permanent cures to justify the operation. The thoroughness of the surgical procedure in completely eradicating the disease should be closely followed in radiation therapy of this condition. Two cases of inoperable breast carcinoma are presented which demonstrate the possibility of completely removing large cancerous masses by roentgen-ray treatment alone.

The author's technic consists in giving an initial full dose of radiation of sufficient quality to produce an effect in all parts of the tumor. If the initial dose is not given at one sitting but divided up into fractional doses, the time required to give the full dose should not be more than four days and the dose should be increased sufficiently to make up for the loss incident to the interval between treatments. It is considered of importance to follow the initial dose by subsequent treatment at an interval which will not allow for recovery of the tumor from the first treatment. This interval should not exceed two weeks, at which time it is necessary to compute the dissipated radiation and apply sufficient radiation to replace this dissipated radiation. This process must be continued until the cancer becomes inactive.

The object of pre-operative radiation is to devitalize the cancer cells so that they will be less likely to grow if they enter the circulation during the operation and are deposited in some distant region. The author does not believe it advisable to delay operation in order to give pre-operative radiation, and when this form of radiation is employed, he is of the opinion that the operation should not be delayed any longer than it takes the patient to recover from the roentgen sickness. The technic used consists of administering a full dose over the breast axilla, and supraclavicular region using 200 K.V. and 0.5 or 0.75 mm. copper filter.

Post-operative radiation is employed to destroy cancer cells that may be left after operation, and has been used by the author for a period of about twenty-five years. While there has been considerable difference in opinion regarding the value of this form of radiation, it is believed that the technic employed and the skill of the radiologist have much to do with the success of this form of therapy. Radiation of a quality produced by 135 K.V. is considered preferable to 200 K.V. for treatment of the breast area and axilla because of the

ACTINOMYCOSIS

Radiation Therapy of Actinomycosis Otto Dyes
Strahlentherapie, 1934, 50, 641-657

Radiation therapy of actinomycosis is of benefit in many cases, provided that sufficiently high doses are applied. In the experience of the author it is necessary to administer approximately 600 r effective in the diseased tissue. This dose should be given within six days. Even patients with involvement of inner organs may be saved unless the destructive process has advanced too far. Iodine medication does not seem to be necessary to obtain good end results. From a cosmetic standpoint alone roentgen therapy is superior to surgery in external lesions, particularly around the mouth and neck.

ERNST A. POHLE, M.D., Ph.D.

ARTHRITIS

The Roentgenologic Picture of Arthritis of the Cervical Spine Luigi Bevilacqua *Arch. di radiol.*, 1934, 10, 182-188

Bevilacqua, of Padua first discusses briefly the embryology and anatomy of the vertebral column and then takes up in detail the cervical spine. In this exposition he emphasizes especially the radiologic examination of the articular apophysis which he carries out by a particular technic which he illustrates.

E. T. LEDDY, M.D.

CANCER (THERAPY)

The Problem of Radiosensitivity Max Cutler
Jour. Am. Med. Assn., Oct. 20, 1934, 103, 1204-1209

Following the discovery of x-rays and radium about thirty-five years ago, the problem passed through a preliminary experimental period of physical and biologic studies that were essential to establish the fundamental basis of radiotherapy. Physicians are only beginning to approach an understanding of some of the principles of radiotherapy and their clinical application to the treatment of cancer.

With present methods, squamous carcinoma fulfills all the criteria of the definition of a radiosensitive tumor but this fact is not known to many pathologists and clinicians. That the microscopic structure of a tumor is only one of a group of factors which indicate the property and degree of radiosensitivity is now fully established. An estimate of radiosensitivity in relation to treatment can, therefore, be made only in consultation between the pathologist and the radiotherapist if erroneous and misleading deductions are to be avoided. Investigation dealing with the physiologic and biologic effects produced in normal and neoplastic tissues exposed to x-rays and radium attempts to explain the method by which irradiation effects the disappearance of tumor cells and at the same time preserves the normal structures. The response of tumors to irradiation is governed by a group of factors including physical, histologic, pathologic and clinical which in combination with one another determine the ultimate result. The failure to recognize the relative im-

portance of all the principles that influence the ultimate result may lead to errors in interpretation of radio-physiologic phenomena. Observations emphasize the inadequacy of microscopic studies alone to predict the response of tumors to radiation therapy. A decision on the choice between operation and irradiation in the treatment of a given tumor is at times exceedingly difficult. Of the several factors that determine the success or failure in the radiotherapy of a given tumor, the factor of radiosensitivity is the most important.

A radiosensitive tumor may be defined as one that can be completely destroyed by a correct irradiation without permanent damage to the surrounding normal structures. The complete sterilization of a tumor by irradiation can be accomplished in two ways: (1) selective radiation and (2) caustic radiation. Selective radiation sterilizes cancer cells without causing serious damage to the surrounding normal structures. Caustic radiation not only destroys the tumor but seriously injures the surrounding normal tissues.

Carcinomas arising from the epidermoid structures of the skin and mucous membrane comply with the criteria of radiosensitivity. Outstanding examples of radioresistant tumors are adenocarcinomas, melanomas, fibrosarcomas, and osteogenic sarcomas. Carcinoma of the breast possesses an intermediate degree of sensitivity.

Regaud and Nogier (1914) and Delbet (1918) observed that when radiation is administered by repeated exposures over a prolonged interval the tumor cells become more resistant and develop a radio-immunity whereas the normal cells become more radiosensitive and more subject to radionecrosis. It was shown experimentally that by prolonging the time of treatment the threshold of cutaneous necrosis is increased by 50 per cent while at the same time the threshold of sterilization is maintained at its original level.

The saturation method of Pfahler and the technic of Coutard are compared and a technic of telerradium therapy, somewhat different from that of Coutard, is given in detail.

CHARLES G. SUTHERLAND, M.D.

The Present Status of Radiation in the Treatment of Cancer Arthur C. Christie *Jour. Am. Med. Assn.*, Sept. 29, 1934, 103, 985-989

The rational basis for radiation therapy goes back to the early discovered fact that embryonal types of cells are more radiosensitive than adult forms. The shorter the life cycle of the cell the more sensitive to radiation, and *vice versa*. Lymphocytes have the shortest life cycle and are, therefore, more sensitive to radiation. Bone and nerve cells have the longest life cycle and are therefore more resistant. Among other factors that are equally important are the general condition of the patient and his reaction to radiation, the immediate tissue environment of the cancer (the cancer bed) and the relation of the growth to vital organs or important tissues that may suffer injury.

preventing a quick return of consciousness. This anesthetic was found also to diminish the severity of the post-encephalographic reaction. The pulse rate, blood pressure, and respiration rate were recorded every few minutes, and no adverse manifestations were noted, whereas without an anesthetic the pulse frequently becomes weak and thready after about 50 c.c. of spinal fluid has been removed. The only objection is the additional expense involved.

The increase in initial intracranial pressure consequent upon its use does not appear to be a contra indication. The age of the patients in the authors' series ranged from 3 to 56 years. The average time required for drainage of the fluid was slightly under one hour. The authors add that no cases with choked discs or posterior fossa tumors have been included so far, although two with frontal and temporal tumors were clearly localized by this method. These two patients were up and free from headache in less than forty-eight hours.

FRACTURES

Badly Healed Fracture of the Styloid Process of the Radius Successfully Treated by Prolonged Immobilization. O. Kapel. *Hospitalstidende*, June 26, 1934, 77, 786-788. (Reprinted by permission from the *British Med Jour*, Oct 6, 1934. Epitome of Current Medical Literature.)

The author finds that in certain fractures, such as those of the os naviculare manus and of the styloid process of the radius, inadequate immobilization may prevent bony union and ultimately lead to a painful wrist with chronic arthritis deformans. When immobilization is not continued long enough pain returns on movement, and it may then be waste of time to practise massage and active movements. A chauffeur, aged 49, fractured the styloid process of the right radius while cranking up a car. For three weeks the wrist was immobilized and thereafter he was treated with massage and movements. As his wrist remained painful he was referred to the author, who secured it in plaster-of-Paris, in a position of slight dorsal flexion, with the fingers perfectly free. The patient was thus still able to do gardening. The plaster was changed every eight weeks and worn altogether for seven months, after which the movements about the wrist and fingers were perfectly free and painless. The successive x-ray examinations when the splint was changed showed progressive healing of the fracture. The author argues that if movements and massage had been continued when he took over this case, the patient would have had an always painful joint, with arthritis deformans and progressive invalidism before him.

Shadows around the Internal Condyle of the Femur. Achille Manara. *Arch di radiol*, 1934, 10, 240-249.

The author discusses in detail the differential diagnosis of these shadows and emphasizes the importance they may have not only medico-legally but in the treatment of fractures of the lower femur and lesions of the knee joint.

E. T. LIDDY, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Cholecystitis and Cholelithiasis of Childhood. Howard B. Hamilton, C. O. Rich, and J. Dewey Bisgard. *Jour Am Med Assn*, Sept 15, 1934, 103, 829, 830.

Potter collected 226 cases of gall-bladder disease in children under fifteen years of age, as follows: fetuses, 2; new born infants, 12; 1-day-old infants, 9; infants, 19; less than 1-year children, 18; one to five year-olds, 26; five to ten-year-olds, 55; and ten- to fifteen-year children, 85. Cholecystitis was associated with stones in 44, no stones in 59, with jaundice in 30, and not stated in 93 cases. Stones were present in 140, absent in 48, and not stated in 128 cases. Primary malignant neoplasms were found in two cases. Jaundice was present in 64, absent in 34, and not stated in 128 cases. The authors report a case in a boy 8 years of age. The gall-bladder wall measured 4 to 5 mm. in thickness and was densely fibrotic and somewhat edematous. It was firmly adherent to the duodenum. The mucosa of the gall bladder was markedly injected and presented small focal areas of necrosis. It contained one stone composed of bile salts. Cholecystectomy was done and the patient's convalescence was uneventful.

CHARLES G. SUTHERLAND, M.D.

The Radiology of the Gall Bladder. H. Graham Hodgson. *Proc Royal Soc Med*, September, 1934, 27, 1473-1478.

It should be remembered that radiology is to be employed as an adjunct to clinical findings in the diagnosis of biliary tract disease. The author briefly reviews the development of radiographic studies of the gall bladder, beginning with the visualization of calculi to the present-day use of gall-bladder dye. A discussion of the technique employed in cholecystography and the interpretations of results is cited among which an absence of the gall bladder shadow indicates (1) that the liver is not excreting the dye, (2) that the cystic duct is blocked, or (3) that there is a breakdown through disease of one or more of the links in the concentrating chain of the gall bladder, that is, either of the mucous membrane or of the vascular or lymphatic drainage. Some of the precautions that are to be taken in obtaining the cholecystograms before rendering a diagnosis in the case of a negative or positive shadow are discussed.

G. E. BURCH, JR., M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Polysographic Studies of Pathologic Gastric Processes, with Particular Reference to the Early Diagnosis of Gastric Carcinoma. Chichio Tamiya and Shuei Nosaki. *Fortschr a d Geb d Röntgenstrahlen*, September 1934, 50, 264-280.

In the June, 1933 issue of this Journal the authors

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Cutaneous and subcutaneous recurrences are usually sensitive to radiation if they have not been neglected and allowed to break down and ulcerate. From 120 to 135 K V, with a filter of from 1 to 3 mm of aluminum, is considered sufficient for these lesions. An erythema dose is applied every two weeks until the nodules disappear. In case in which the recurrent lesion is larger and from one half to one inch in thickness it is best to use high voltage therapy at once, applying from 1,000 to 1,100 r at the initial dose, using 200 K V and 0.5 mm copper filter.

J N ANÉ, M D

CHRONIC INFECTIONS

The Etiology of Lymphoblastoma Arthur U Desjardins Jour Am Med Assn, Oct 6, 1934, 103, 1033-1036

The factor immediately responsible for lymphomatous hyperplasia of the lymphoid structures is chronic infection of any kind. This may be tuberculous, pyogenic, or even syphilitic, in fact, the variety of infection is of little consequence provided the infectious element has been present for a sufficiently long time. The duration of infection may vary considerably in different patients. Evidence of long standing will be obtained in the majority of cases. The historical inquiry should be directed to trouble with the teeth, sore throat sinusitis, repeated earache frequent bronchial colds or disorders involving the gall bladder gastro intestinal and genito-urinary tracts. The practically constant association of infection and primary lymphadenopathy in the same region and on the same side of the body can hardly be regarded as a coincidence.

In a small proportion of cases (less than 10 per cent) also more or less clear indications of an antecedent tuberculous process may be noted but in the majority of patients tuberculosis does not appear to play an etiologic part.

A predisposing factor also is required to provide a suitable background for the immediate cause. This additional and essential element is probably to be found in a hereditary predisposition or tendency transmitted from generation to generation, of the lymphoid tissue to react in a certain way to various noxious influences.

Twelve case histories have been reviewed in detail to illustrate these contentions.

CHARLES G SUTHERLAND, M D

CONTRAST MEDIA

Unusual Pyelographic Observations (Penetration into the Renal Parenchyma and Perforations) J Arendt and H Brockmann. Fortschr a d Geb der Röntgenstrahlen, April, 1934 49, 335-341

Several such accidents of instrumental pyelography are described especially a fistulous tract leading off

a pyonephrotic renal pelvis on the left side into the duodenum. Furthermore, tubular injections and so-called pyelovenous reflux are shown—a differentiation between these two manifestations is demonstrated on the basis of investigations by Fuchs and Minder. Finally, demonstration of the renal veins as a result of pyelovenous reflux is described, resulting possibly on account of the presence of blocking accessory vessels—arteries. All cases reported showed evidence of real renal disease. The opinion is expressed that the observations of such accidents indicate an incontinuity of the renal pelvis and parenchyma to pressure in the presence of a pathologically altered renal mucosa and parenchyma.

(We are of the opinion that two factors are entirely overlooked in this article. First, absorption of contrast medium in the renal parenchyma seems possible. Such an absorbed contrast medium probably should delineate not the renal veins but more likely the renal lymphatics. Secondly, we doubt that pyelovenous reflux ever has been proven conclusively that, on the contrary, a pyelolymphatic reflux would seem to be a much more logical explanation of some of the images discussed.)

H A JARRE, M D

Excretory Urography after Subcutaneous Injection of Neoskiodan Edwin Beer and Frederick H Theodore. Jour Am Med Assn, July 21, 1934, 103, 181-183

In 1931 Butzengeiger first attempted subcutaneous injection of skiodan in adults, using a 4 per cent (isotonic) solution and injecting 500 c c containing 20 gm into the axilla. In 30 cases he reported results almost as satisfactory as those obtained by intravenous injection. The maximum excretion appeared from thirty to fifty minutes after injection, and there were no local or general deleterious effects. Hillebrand used the method in 1932 to demonstrate a renal tumor without disturbance, inflammatory or necrotic at the site of injection in the axillary tissues.

In the service at Mount Sinai Hospital 15 patients 10 of them children have been injected in this way with fairly satisfactory results. The best urographic shadows were obtained about fifty to sixty minutes after injection. Good urograms can be made at any time from thirty to ninety minutes after injection in the authors' experience.

CHARLES G SUTHERLAND, M D

ENCEPHALOGRAPHY

Encephalography under Nitrous Oxide Anesthesia R W Waggoner and L E Hymler. Am Jour Roentgenol and Rad Ther June 1934 31, 784-786 (Reprinted by permission from the British Med Jour Oct 6, 1934 Epitome of Current Medical Literature)

The authors record 13 cases of encephalography in which nitrous oxide anesthesia obviated all subjective symptoms while the fluid was being removed without

preventing a quick return of consciousness This anesthetic was found also to diminish the severity of the post-encephalographic reaction The pulse rate blood pressure, and respiration rate were recorded every few minutes, and no adverse manifestations were noted, whereas without an anesthetic the pulse frequently becomes weak and thready after about 50 c c of spinal fluid has been removed The only objection is the additional expense involved

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E T LEDDY M D

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CHRONIC INFECTIONS

The Etiology of Lymphoblastoma Arthur U Desjardins Jour Am Med Assn, Oct 6, 1934 103, 1033-1036

The factor immediately responsible for lymphoblastic tomatous hyperplasia of the lymphoid structures is chronic infection of any kind. This may be tuberculous, pyogenic, or even syphilitic, in fact, the variety of infection is of little consequence, provided the infectious element has been present for a sufficiently long time. The duration of infection may vary considerably in different patients. Evidence of long standing will be obtained in the majority of cases. The historical inquiry should be directed to trouble with the teeth, sore throat, sinusitis, repeated earache, frequent bronchial colds or disorders involving the gall bladder, gastro-intestinal and genito urinary tracts. The practically constant association of infection and primary lymphadenopathy in the same region and on the same side of the body can hardly be regarded as a coincidence.

In a small proportion of cases (less than 10 per cent) also more or less clear indications of an antecedent tuberculous process may be noted, but in the majority of patients tuberculosis does not appear to play an etiologic part.

A predisposing factor also is required to provide a suitable background for the immediate cause. This additional and essential element is probably to be found in a hereditary predisposition or tendency transmitted from generation to generation of the lymphoid tissue to react in a certain way to various noxious influences.

Twelve case histories have been reviewed in detail to illustrate these contentions.

CHARLES G. SUTHERLAND, M.D.

CONTRAST MEDIA

Unusual Pyelographic Observations (Penetration into the Renal Parenchyma and Perforations) J. Arendt and H. Brockmann. Fortschr. a. d. Geb. der Röntgenstrahlen, April, 1934, 49, 335-341.

Several such accidents of instrumental pyelography are described especially a fistulous tract leading off

a pyonephrotic renal pelvis on the left side into the duodenum. Furthermore, tubular injections and so-called pyelovenous reflux are shown—a differentiation between these two manifestations is demonstrated on the basis of investigations by Fuchs and Minder. Finally, demonstration of the renal veins as a result of pyelovenous reflux is described, resulting possibly on account of the presence of blocking accessory vessels—arteries. All cases reported showed evidence of real renal disease. The opinion is expressed that the observations of such accidents indicate an incontinuity of the renal pelvis and parenchyma to pressure in the presence of a pathologically altered renal mucosa and parenchyma.

(We are of the opinion that two factors are entirely overlooked in this article. First, absorption of contrast medium in the renal parenchyma seems possible. Such an absorbed contrast medium probably should delineate not the renal veins but more likely the renal lymphatics. Secondly, we doubt that pyelovenous reflux ever has been proven conclusively; that, on the contrary, a pyelolymphatic reflux would seem to be a much more logical explanation of some of the images discussed.)

H. A. JARRE, M.D.

Excretory Urography after Subcutaneous Injection of Neoskiodan Edwin Beer and Frederick H. Theodore Jour Am Med Assn July 21, 1934, 103, 181-183.

In 1931 Butzengieger first attempted subcutaneous injection of skiodan in adults, using a 4 per cent (isotonic) solution and injecting 500 c.c. containing 20 gm into the axilla. In 30 cases he reported results almost as satisfactory as those obtained by intravenous injection. The maximum excretion appeared from thirty to fifty minutes after injection, and there were no local or general deleterious effects. Hillebrand used the method in 1932 to demonstrate a renal tumor without disturbance, inflammatory or necrotic at the site of injection in the axillary tissues.

In the service at Mount Sinai Hospital 15 patients, 10 of them children, have been injected in this way with fairly satisfactory results. The best urographic shadows were obtained about fifty to sixty minutes after injection. Good urograms can be made at any time from thirty to ninety minutes after injection in the authors' experience.

CHARLES G. SUTHERLAND, M.D.

ENCEPHALOGRAPHY

Encephalography under Nitrous Oxide Anesthesia R. W. Waggoner and L. E. Himler. Am Jour Roentgenol and Rad Ther June, 1934 31, 784-786 (Reprinted by permission from the British Med Jour Oct 6 1934 Epitome of Current Medical Literature).

The authors record 13 cases of encephalography in which nitrous oxide anesthesia obviated all subjective symptoms while the fluid was being removed without

which is not tender and is unassociated with bone changes. It usually involves the knee and may be unilateral but is more frequently bilateral. A synovitis is the primary and most important pathologic process. The condition is seen for the most part in syphilitic children and is the most common form of syphilitic change in the joints in the congenital variety of the disease. Syphilis of the joints occurring in infants is represented by inflammation secondary to involvement of the neighboring epiphysis. Serous synovitis (Clutton's joints) in adults, the subjects of acquired syphilis, is uncommon and usually precedes or accompanies the secondary eruption.

Roentgenographic examination shows no changes in the bone. The picture is merely that of a distention of the joint. Pathologically the synovial membrane is infiltrated and studded with gummas and is everywhere thickened and much more vascular than normal.

CHARLES G. SUTHERLAND, M.D.

THE LUNGS

The Estimation of Functional Disability in the Pulmonary Fibroses. William S. McCann, Alberto Hurtado, Nolan Kaltreider and Walter W. Fray. *Jour Am Med Assn*, Sept 15, 1934, 103, 810-814.

Pneumoconiosis presents a medico-legal problem of major importance. It is essential that objective means of estimating disability be sought which will be fair alike to workmen and employer in view of the growing tendency to adjust awards of workmen's compensation to the degree of disability.

The function of respiration is one jointly mediated by the heart, the blood and the lungs. The authors have carried out investigations on the respiratory function of 53 cases of pulmonary fibrosis, not all of which were cases of pneumoconiosis. Their studies dealt with the pulmonary capacity and its subdivisions, with the tidal air, dead space, alveolar gases and response of the pulmonary ventilation to exercise. They included the usual diagnostic roentgenographic studies, together with measurements of areas of the pulmonary fields during maximum inspiration and expiration, with observations as to the behavior of the ribs and diaphragm. The blood was studied in each case as to count, hemoglobin, cell and plasma volume, and gas content, particularly of the degree of saturation of the arterial blood with oxygen. The heart was carefully measured roentgenographically. Electrocardiograms were made in each case and the cardiac output was measured in a large proportion of them. The total pulmonary capacity and its subdivisions were measured by the method of Christie.

In order to determine to what extent the roentgenograms of the lungs gave clues as to the degree of functional impairment of respiration, the cases of pulmonary fibrosis were divided into six groups, according to the anatomic type of fibrosis revealed. The comparison of the observed with the normal calculated pulmonary capacity in cases of pulmonary fibrosis indi-

cated that a decrease in the total and vital capacities and an increase in the residual air are characteristic changes in this condition. These changes tend to become more accentuated as the degree of fibrosis increases, but frequent exceptions to this correlation emphasize the fact that one cannot judge accurately the degree of abnormality in pulmonary capacity from roentgenograms alone.

CHARLES G. SUTHERLAND, M.D.

Congenital Cystic Disease of the Lungs. A Clinical Study. Harry G. Wood. *Jour Am Med Assn*, Sept 15, 1934, 103, 815-821.

Cases fall into two groups: (1) those in which there are single or multiple large cysts containing air and fluid and (2) instances of diffuse degeneration resulting in the so-called honeycomb type of lung. The congenital origin of this disease is still a matter of contention but in many cases the lesions are palpably present at birth and more important still in specimens obtained in later life, pigment is absent almost invariably. No simple mechanical explanation is available for what is manifestly a developmental anomaly of which many of the factors are unknown.

Sixteen cases observed at the Mayo Clinic are reviewed in detail. In this series the lesions were wholly or chiefly limited to the right side of the thorax in eight cases and to the left in five. In three, the lesions were bilateral and of the honeycomb type. In three of the others in which the lesions were chiefly unilateral, there was evidence of bilateral involvement. Of the thirteen cases in which the lesions were chiefly unilateral, the cysts contained fluid in five, and air in eight. Both tuberculosis and syphilis seemingly can be ruled out as etiologic factors. Thirteen patients came to the Clinic with complaints associated with the pulmonary lesions, while in three the pulmonary lesions were purely incidental.

Extensive lesions may be present with very few, or no, symptoms. The clinical manifestations vary greatly and depend chiefly on the extent of the lesions, on their site and on whether or not there is a change in intrathoracic pressure. Most characteristic of all is a history obtained particularly with reference to infants and children, of recurring attacks of severe dyspnea with cyanosis. Such attacks occur only when an imperfect bronchial communication exists. When progressive dyspnea develops in adults, without apparent cause, and with or without a preceding respiratory infection, the possibility of congenital cystic degeneration of the lungs should be considered. Theoretically, with increased intrathoracic pressure, the displacement of the heart and mediastinal structures should be away from the lesion. The differential diagnosis involves thoracic tumor, pulmonary abscess, empyema, dermoid cyst and echinococcus cyst.

Bronchoscopic examination and injection of iodized oil and the injection of air into the pleural cavity have been of assistance in the diagnosis.

Complete extirpation of fluid-containing cysts,

published a paper in which they showed that the old method of "polygraphy" still must be regarded as a valuable technical procedure for the analysis of physiologic and pathologic motor phenomena of the stomach. They were able to confirm Fränkel's conception of localized marginal gastric rigidity and his evaluation for the recognition of ulcerative and infiltrative lesions.

The present paper is an experimental study on the stomach of cats following artificial production of tumor like infiltrations by the injection of from 8 to 10 per cent solution of zellodine in a mixture of alcohol and ether. From their experiments the authors conclude that lesions measuring 0.7 sq. cm., located either in the mucosa or submucosa or involving the entire thickness of the gastric wall can be recognized in "polisograms." The criterion for their recognition, as stated in the previous paper and quite in agreement with other authors—Fränkel, Bernstein, Assmann and others—is the localized marginal rigidity. Additional conclusions are drawn as to the occurrence of spastic retractions opposite the organic lesions, the shortening of the lesser curvature, especially the pyloric segment with gradual extension of a pathologic process and the effects of peritoneal adhesions in extra ventricular tumors, the two latter frequently leading to a diminution of peristalsis rather than a fixation of the gastric wall.

It is interesting to record that a method which is now nearly twenty-five years old and has been forgotten for many years, still can produce very satisfactory results in the hands of careful experimenters. As it is a very simple technical procedure, it might well be employed more frequently, not to the exclusion of more modern methods, especially the ones of relief studies, but as an addition to such valuable procedures.

HANS A. JARRE, M.D.

The Importance of Roentgenologic Examination in Diverticulosis of the Colon. Giuseppe Brancadoro. Arch. di radiol., 1934, 10, 225-239.

Brancadoro presents three cases of diverticulosis of the colon, with various symptomatology in which a roentgenologic examination carried out in various ways alone made the correct diagnosis. After a discussion of the pathogenesis and symptomatology of diverticulosis and diverticulitis he insists on the necessity of considering diverticulosis as a possibility in obscure cases.

E. T. LEDDY, M.D.

Chronic and Productive Lesions of the Terminal Ileum Studied by Mirrored Serigraphy. P. Perona. Arch. di radiol., 1934, 10, 145-181.

Perona, of Padova, having shown that the terminal ileum resembles the stomach in many ways—morphologically, functionally and in the architecture of its mucosa—points out how frequently appendicitis is associated with catarrhal enteritis and how one condition may simulate the other. He therefore emphasizes the importance of a serigraphic study of the mucosa

of the ileum and illustrates some aspects of ileal catarrhal enteritis which reproduce in part at least the picture of chronic gastritis and colitis. Among these he points out that *follicular enteritis* has a picture which may resemble that of papillomatosis.

In conclusion he discusses the differential diagnosis between tuberculoma and blastomatous lesions in the ileo-cecal region and points out that a study of its filling may furnish evidence about its functional and structural peculiarities which may differentiate them.

E. T. LEDDY, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

The Management of Urologic Complications in Injuries to the Spine. Report of 54 Cases without a Single Infection in the Urinary Tract. J. F. Connors and I. E. Nash. Am. Jour. Surg., October, 1934, 26, 159.

The literature on injuries to the spine has been reviewed with especial reference to morbidity and mortality statistics both in military and civil practice.

The pathologic physiology occurring in the spinal cord and in the urinary tract is described briefly.

Infection of the urinary tract is found to be the most important cause of death in these injuries. Catheterization of the bladder is accepted as the cause for infection in the opinion of almost all commentators.

The management of the urologic complications has been outlined, stress being laid upon the absolute necessity for the avoidance of catheterization. The authors are aware that some cases are not infected by catheterization but they feel that this is a matter of luck rather than sound judgment. They feel that twenty years of clinical experience justifies their views on this subject.

An analysis is made of 54 cases treated in Harlem Hospital without a single infection in the urinary tract.

DAVIS H. PARDOLL, M.D.

HEART AND VASCULAR SYSTEM

The Radiologic Diagnosis of Exudative Pericarditis. Benedetto Marini. Arch. di radiol., 1934, 10, 189-207.

Marini recalls the well known fact that in some cases a radiologic diagnosis of exudative pericarditis is very easy to make and in others very difficult if not impossible. He illustrates four cases he studied by various methods of examination and emphasizes that it is not safe to rely on one method of examination but that it is better to use all available clinical and roentgenologic evidence together to make the diagnosis.

E. T. LEDDY, M.D.

JOINTS

Symmetrical Serous Synovitis (Clutton's Joints). Congenital Syphilis and Interstitial Keratitis. Joseph V. Klauder and Harold F. Robertson. Jour. Am. Med. Assn., July 28, 1934, 103, 236-240.

Clutton's joints refers to a painless hyarthrosis

cal theory of action Uncombined silica causes a very rapid necrosis of tissues, which is not produced by silicates and non siliceous dusts If the concentration of silica is too low or if the particles are larger than 4 microns in diameter, the response is less intense and no necrosis develops Sericite produces inflammation but no necrosis, its action simulates that of granite, a mixture of silicates with quartz Other substances containing no silica are practically inert Cellular response to silica is due to some other property than solution, or ions liberated from free silica are more active than those from the silicates In South Africa, Irvine has stated that about 75 per cent of all silicotic persons will die of tuberculosis and the same is probably true in this country

The evolution of uncomplicated silicosis is depicted in the light of experimental observations and of the few early cases of human silicosis that have come to autopsy In the first stage of the legally recognized disease, the roentgenographic examination reveals minute nodules throughout the middle portions of the lung field, often more marked on the right side. As the condition progresses these nodules increase in size and blot out the previous prominent linear markings In the second stage the nodular shadows become so large that they tend to become confluent and obscure all the normal markings However, they still retain their uniform distribution and the outlines of the individual units are fairly well defined

Human silicosis begins by damaging the pulmonary lymphatic apparatus and is followed by the development of nodular fibrosis of the parenchyma of the lungs Silicosis specifically predisposes to infection with the tubercle bacillus The mechanism of this action has not yet been determined, though it probably consists in some alteration of the soil rather than in changes induced in the infecting organism Non siliceous dusts localize about the lymphatic trunks and some of them excite the proliferation of small amounts of connective tissue (loose cellular), and they apparently do not increase susceptibility to tuberculosis Non-siliceous dusts inhaled in combination with silica modify the action of the latter, altering the anatomic characteristics of the lesions and apparently decreasing the susceptibility to tuberculosis

CHARLES G SUTHERLAND, M D

THE SKULL (DIAGNOSIS)

The Roentgen Image of the Third and Fourth Cerebral Ventricles O Dyes *Fortschr a d Geb d Rontgenstrahlen*, September 1934 50, 230-240

The posterior portions of the cerebral ventricular system are not as readily demonstrable as are the anterior ones because of escape of the contrast medium through the aqueduct when patients are in prone frontal positions However, with a sufficient exchange of cerebrospinal fluid and air and possibly also additional introduction of lipiodol, a satisfactory demonstration of the detailed structure of the third and fourth ventricles often can be obtained It may be desirable

to include fluoroscopic observations in the technical procedures, especially of the distribution of opaque oil, with additional roentgenographic records made instantaneously during various phases of the fluoroscopic observations Several case reports show successful diagnoses of a dural endothelioma and a glioma in the frontal lobes, furthermore, tumors of the cerebellum and the cerebral peduncles These latter tumors produce protrusions of the posterior wall and the floor of the third ventricle and displace the aqueducts

In several cases investigated carefully so far, a definite differentiation between tumors of the pons and the cerebellum could be made, facilitating indications for operation

H A JARRE, M D

THE SPINE

Calcification of the Nucleus Pulposus Armando Zuppa *Arch di radiol*, 1934, 10, 250-261

Zuppa concludes that (1) calcification of the nucleus pulposus is a disease entity characterized roentgenologically by an opacity in the intervertebral disc (2) These shadows, in the lateral radiograph may be seen in the anterior or posterior portion of the disc according to the segment of the spine in which they are observed, and this is because of anatomical factors (3) The observation of these shadows may be important in the differential diagnosis of calcification in the disc from other affections (4) This condition is associated with ankylosing spondylitis which often accompanies it (5) Calcification of the nucleus pulposus may be due to a lesion in the sympathetic, of toxic, infectious, or traumatic nature, which changes the lymphatic status of the disc and which produces trophic changes such as calcification of the nucleus pulposus or the intervertebral disc or calcification of all the ligaments

E T LEDDI, M D

THYROID (THERAPY)

X-ray Treatment in Some Conditions of the Thyroid and Thymus H Davies *British Jour Radiol*, June, 1934, 7, 362-371 (Reprinted by permission from *British Med Jour*, Oct 6, 1934, *Epitome of Current Medical Literature*)

While admitting that x ray therapy can show a high percentage of successful results in the treatment of over-activity and of enlargement of the thyroid and thymus glands, H Davies believes that, if cases of thyrotoxicosis were more carefully grouped and operation were regarded as the method of choice in the secondary type, with x ray treatment in the primary type, the results would be still better Primary thyrotoxicosis occurring in the young adult is attended by an appreciable operative risk and an operative cure of only about 80 per cent, whereas the safer x-ray therapy can be shown by large series of cases to be just as effective Davies considers that the indication for x-ray treatment in thyroid disease is over-activity of

bronchoscopic aspiration followed by injection of iodized poppy seed oil has been useful in treatment. Diffuse, bilateral cystic degeneration of the so-called honeycomb type is not benefited by any form of treatment.

CHARLES G SUTHERLAND, M D

Pulmonary Lesions Produced by Paraffin Oil
E Ellinger Fortschr a d Geb d Röntgenstrahlen,
April, 1934, 49, 397-403

Three cases are reported of rather extensive indurative pneumonic consolidation of basal pulmonary segments which were traced to prolonged instillation of rather large quantities of paraffin oil. Reference is made to a similar case reported by Fischer-Wasels in which the diagnosis was confirmed at autopsy, and also to a case reported by Bodmer and Kallós in which the diagnosis was made during the lifetime of the patient. Reports of American authors (Laughlen, Pinkerton, Pierson) are cited concerning pneumonia in children, resulting from aspiration of mineral and animal oils.

The roentgen image is not characteristic and can hardly be differentiated from other indurative pneumonic processes involving the lower lobes. A reliable diagnosis can be obtained only with due consideration of the patient's history. For differential diagnosis, one must consider tuberculosis, bronchiectases with pneumonitis, carcinoma of the bronchus, tertiary pulmonary syphilis, pulmonary lymphogranuloma, actinomycosis, and a sarcoid pulmonary tumor described by Boeck.

The prognosis of these pulmonary lesions is relatively favorable as the process is of but slow progression even in the instance of instillation of the injurious oils which has extended over many years.

Paraffin oil in the air passages, especially for treatment of nasal and laryngeal disease, preferably should be omitted completely, and replaced by saponifiable vegetable oils.

H A JARRE, M D

The Surgical Treatment of Carcinoma of the Bronchi and Lungs
William F Rienhoff, Jr and Edwin N Broyles Jour Am Med Assn Oct 13 1934 103, 1121-1128

The total removal of the entire lung bids fair to become eventually the operation of choice in the surgical treatment of malignant tumors of the bronchi and lungs. The development of a rational safe and thorough operative procedure is therefore of prime importance. The authors report two successful cases of pneumonectomy.

Incidental to the development of an operative technique for the removal of the thoracic esophagus it became evident that compression of the lung by an artificial pneumothorax would serve two very valuable purposes, *i.e.*, first the patients were able to adapt themselves to breathing with the non-collapsed lung and also adjust themselves to the altered conditions of intrathoracic pressure that would exist during and

after the operation. Thus the shock attendant on opening the pleural cavity was negligible. The second purpose was to remove the lung mechanically as far as possible from the operative field so as to give the maximum exposure of the mediastinum with the minimum handling of the lung. The surgical procedure is described in detail.

CHARLES G SUTHERLAND, M D

PNEUMONIA

X ray Diagnosis of Pneumonia Joseph E Roberts
Jour Med Soc of N J October 1934, 31, 568-569

With the use of the x ray the various pathologic changes of pneumonia may be followed throughout the course of the disease, beginning with the stage of congestion and continuing through resolution, all of which present rather characteristic findings.

G E BURCH, JR, M D

SILICOSIS AND PNEUMONOCONIOSIS

Inhaled Silica and its Effect on Normal and Tuberculous Lungs
Leroy U Gardner Jour Am Med Assn, Sept 8, 1934, 103, 743-748

A very convincing array of clinical, statistical and experimental observations has demonstrated that dusts composed, in whole or in part, of silica are capable of exciting a characteristic, progressive, nodular fibrosis of the lungs and that at the same time these organs become abnormally susceptible to the tubercle bacillus. All the other types of dust that have been thus far investigated can apparently be inhaled almost with impunity for long periods of time.

It was originally claimed that only uncombined or free silica in the form of quartz was capable of producing this effect, but in recent years there has been a growing tendency to look with suspicion on some of the silicates (combinations of silica with bases). One of these, asbestos, a silicate of magnesium, is now a well recognized cause of pulmonary fibrosis, although the reaction is diffuse and not nodular in character. Jones claims that a silicate and not free silica is the important factor in the production of all cases of silicosis. Where silicosis developed he found a fibrous silicate of aluminum and potassium called sericite in association with the quartz, and in cases in which there was no sericite there was no silicosis. Experimentally and practically pure quartz has produced lesions essentially the same as those found in human silicosis.

Gye and Purdy demonstrated that silica in colloidal form is a cell poison which injected intravenously in large doses causes almost instant death but in smaller quantities produces proliferation of connective tissue. They proposed the hypothesis that particulate silica in the form of quartz is slowly dissolved in the alkaline fluids of the body, liberating minute quantities of colloidal silica which constitutes the irritant responsible for the proliferation of the connective tissues. Chemical proof of this is difficult but there is considerable indirect experimental evidence which favors the chemical

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the secretory epithelium, while in the thymus not only has such secretory over-activity to be considered as an indication, but also simple enlargement due to over-growth of the lymphoid tissue. A point to be emphasized is that recurrence in primary cases treated by operation is as high as 6 to 7 per cent, and this must be taken into account when considering the statistics of successful results in x ray treatment as compared with operation.

If care is exercised, the risk of skin damage should be *nil* and the risk of myxedema negligible. Moreover, x-ray treatment has the advantage that it can be graded, whereas at an operation the amount of thyroid tissue removed is final. The author has treated with x-rays three cases of myasthenia gravis with enlargement of the thymus associated with enlargement of the thyroid and some hyperplasia. In one instance there was definite improvement after one month, persisting for eighteen months. In the other two cases there was immediate and striking improvement, but the sequel is unknown.

The amount of radiation required to produce a good effect in the thymus is small. In view of the close connection which has been shown to exist between the lymphoid tissue of the thymus and thyroid and other conditions, the thymus should receive careful attention when treatment is being undertaken.

VASOMOTOR DISTURBANCES

Roentgen Therapy of Vasomotor Disturbances of the Extremities. R. Gilbert and L. Babaianz. *Rev. Med. de la Suisse Romande*, July 25, 1934, 54, 725-741. (Reprinted by permission from *British Med. Jour.*, Oct. 6, 1934, *Epitome of Current Medical Literature*.)

Owing to the action of x-rays on the sympathetic nervous system, the authors have made use of them in vasomotor and trophic diseases of the extremities, such as intermittent claudication, Raynaud's disease, etc. Paravertebral irradiations of the sympathetic ganglia and deep plexuses, either alone or combined with irradiation of the peripheral endings, have given excellent results. The authors have employed this method in eleven cases, five of which are here recorded. With a semi-penetrating moderately filtered irradiation, total doses of 500 to 800 r, spread over two to three weeks, are given in bi- or tri-weekly irradiations, 175 r is given per field at each treatment. If results are not obtained, the series is repeated after an interval of two or three weeks. Spinal irradiations are first given, and, if improvement be tardy, peripheral ones are added. For diseases of the upper extremity, irradiations are made over the cervical and two first dorsal vertebrae and for those of the lower limbs over the tenth dorsal to the first lumbar vertebrae.

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